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ABSTRACT

This citizen's guide to ensuring a safe supply of drinking water for all provides the information and analysis that individuals need to understand the issues and to participate in local decision making. The sources of drinking water, the types of human activities that results in contamination, and the contaminants that are of most concern are discussed. The workings of a typical treatment plant, who is responsible for ensuring the safety of drinking water, the requirements and effectiveness of the federal Safe Drinking Water Act (SDWA) of 1974, and the substantive changes made by the 1986 amendments to the act are described. Next, this guide surveys the various problems and issues in the management of drinking water. Discussions on how best to provide safe drinking water, what is considered safe, and what it will cost to provide a safe supply of drinking water are topics of discussion. The handbook concludes with a Guide to Citizen Action, designed to help readers learn more about the quality and management of local drinking water and to take action on issues of local concern as well as protect home water supplies. A glossary is provided, followed by a resource list that includes publications, national environmental organizations, health information organizations, professional membership organizations, state drinking water contacts, and organizations represented by contributing authors. (KR)

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A Citizen's Drinking Water Handbook

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SAFETY ON TAP

A Citizen's Drinking Water Handbook

League of Women Voters Education Fund

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Introduction

Is our drinking water safe? As with any public policy issue, it depends who you ask. The reality is that the quality of drinking water depends on a number of factors, the most important of which is local conditions.

"Contamination of U.S. drinking water is not some theoretical potential problem, or something that rarely occurs. The problem is here, now. One of the best kept public secrets seems to be how woefully inadequate the Safe Drinking Water Act has been in encouraging plant upgrading and protecting tap water."

Merilyn Reeves, former member of EPA's National Drinking Water Advisory Council and member of the League of Women Voters National Board

Nationally, public confidence in the quality of drinking water is high. A 1985 national survey by the American Water Works Association Research Foundation found that 87 percent of those surveyed judged the quality of their tap water to be average or above. This level of confidence is largely a reflection of the long record of success the nation has achieved in controlling the "traditional" waterborne contaminants—bacteria and viruses that carry diseases such as cholera and typhoid.

As incidences of drinking water contamination increase, however, many consumers are questioning the quality of the water coming from their taps. And despite the public's apparent confidence in the ability of our public water systems to provide high quality water, reliance on bottled water and home treatment devices as an alternative to tap water steadily grows.

Is our drinking water safe? In the past, water was considered safe if it was free of disease-causing bacteria and viruses. But a number of significant events have reopened the question of what is "safe" and refocused the attention of the public and the public health community on the relationship between drinking water quality and health. Evidence shows that an expanding number of chemicals used daily in commerce are finding their way into the environment, and technology has advanced our ability to detect and identify substances at very low levels in drinking water. Moreover, we are continually learning about the long-term health effects of contaminants on a population that is living longer.

This citizen's guide provides the information and analysis that individuals need to understand the issues and to participate in local decision making. Indepth scientific or technical expertise is not required to make a difference. Interested citizens can readily understand and affect drinking water issues and policies.

Safety on Tap discusses the sources of drinking water, the types of human activities that result in contamination and the contaminants that are of most concern. It also describes how a typical treatment plant works, who is responsible for ensuring the safety of your drinking water, the requirements and effectiveness of the federal Safe Drinking Water Act (SDWA) of 1974, and the substantive changes made by the 1986 amendments to the act.

Next, *Safety on Tap* surveys the various policy issues involved in the management of drinking water. In order to ensure a wide variety of viewpoints and to garner the expertise of key policy makers in the field of drinking water, the League of Women Voters Education Fund asked a range of recognized experts to share their thoughts on a number of issues central to the debate. These contributions underscore the reality that within the overall goal of providing safe drinking water, opinion diverges significantly on how best to provide it, on just what is considered safe, and on what it will cost to provide a safe supply of drinking water for all.

Safety on Tap concludes with a Guide to Citizen Action to help readers learn more about the quality and management of local drinking water and to take action on issues of local concern. And in the spirit of the SDWA Amendments of 1986, which emphasize that preventing contamination of water supplies in the first place is the most sensible and cost-effective method of ensuring safe water, the Guide to Citizen Action provides information on how we can each act responsibly at home to protect our water supplies.

1 Our Drinking Water: Sources of Supply and Contamination

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Sources of Drinking Water

The water that eventually makes its way to the consumer's tap "originates" as either a ground or surface water source. Of course, the term "originates" is technically inaccurate and misleading; water is in constant cycle, mixing and moving in the form of clouds, precipitation, groundwater, rivers and oceans. Surface waters include rivers, streams, lakes and reservoirs, while groundwaters include springs and aquifers. An aquifer is an underground reservoir: a formation of sand, gravel, limestone or other porous material that is saturated with enough water to provide a reliable supply when "tapped." Aquifers are "recharged," or resupplied, by the percolation of rainwater, snow and hail down through soils. Surface waters and groundwaters are in constant balance. In times of drought, groundwater can replenish rivers, lakes and streams, and in times when water is plentiful, groundwater can be replenished by these same surface waters. Like surface waters, groundwater flows, but at a much slower rate (generally only a few inches to several feet each day).

The manner in which drinking water arrives at the consumer's tap depends on a community's location and population and on the accessibility to water. In substantially populated areas, a centralized water treatment and delivery system is usually established, drawing on the cleanest source of ground or surface water available. This centralized system, which may be publicly or privately owned, is called a water utility. In more rural areas, families most frequently rely on their own (referred to as private or individual) wells.

Threats to Drinking Water Quality

Contamination of drinking water can occur before the water is treated for drinking purposes, during the treatment process itself or following treatment, in the distribution system.

Before Treatment

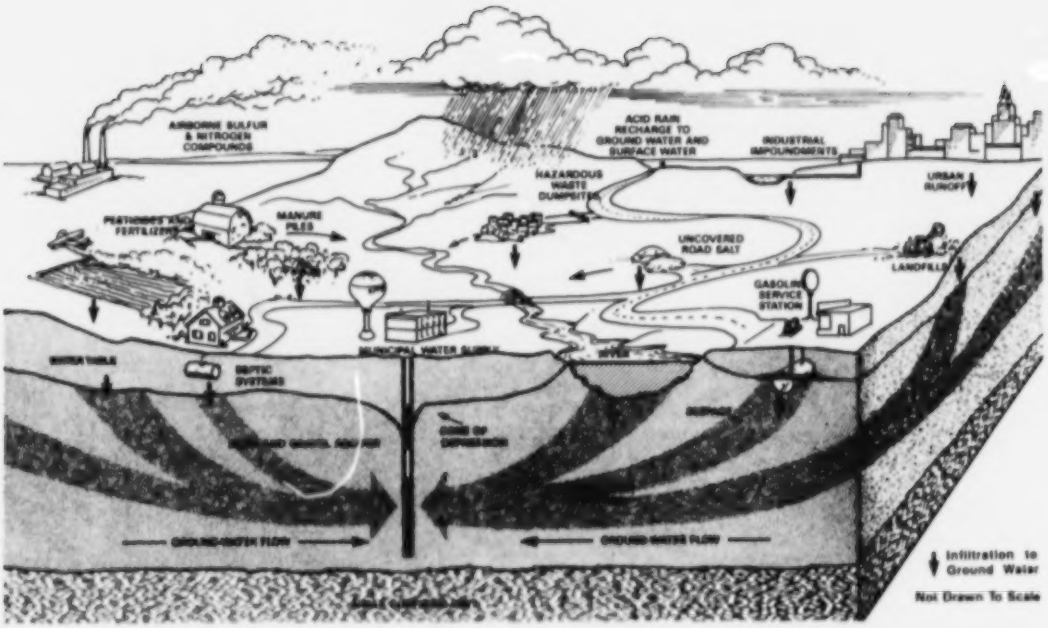
A wide range of enterprises in our society can be linked to the contamination of drinking water by hazardous substances. In addition to activities in the home, industries such as dry cleaners, photo labs, water and wastewater treatment plants, and chemical and petroleum production all require disposal of wastes capable of contaminating drinking water. (See Figure 1.) Waste disposal activities threaten both ground and surface water supplies primarily through the natural process of precipitation; rain or snowmelt moves through a waste site, becoming contaminated and then seeping directly into the groundwater or running off into surface water supplies. The major waste disposal methods that threaten water quality are discussed below.

Land Disposal: Landfills (dumps) and surface impoundments (pits, ponds and lagoons used to store, treat or dispose of wastes) are examples of land disposal of wastes.

A 1984 census by the Environmental Protection Agency (EPA) reported an estimated 16,416 active municipal and industrial landfills in the United States. These landfills are repositories for all types of solid waste, including agricultural wastes, municipal sludges, household hazardous wastes and industrial wastes.

The federal hazardous waste disposal program (mandated by the Resource Conservation and Recovery Act) legally exempts approximately 378,000 businesses from special hazardous waste disposal restrictions, allowing their wastes to also be buried in municipal or industrial landfills or surface impoundments. Only 19 percent of landfill operators monitor groundwater quality under landfills, and approximately 8.5 percent monitor impacts on surface water quality.

EPA's National Priority List of hazardous waste sites (those designated for clean-up) includes 184 municipal and industrial so-called "nonhazardous" landfills. And, a 1982 EPA study



of the nation's total 929 hazardous waste sites showed drinking water was contaminated at 128 sites and was suspected to be contaminated at 213 additional sites. The same study reported confirmed or suspected groundwater contamination at two-thirds of the hazardous waste sites.

In 1983, EPA estimated that there are 181,000 surface impoundments in the United States, of which 93 percent have high or intermediate potential to contaminate groundwater. Thirty percent of these impoundments, used for the disposal of brine and municipal, industrial, mining and agricultural wastes, overlie vulnerable potable (i.e, drinkable) aquifers. Monitoring to detect the groundwater contamination is conducted at 4 percent of these surface impoundments; monitoring for surface water contamination is conducted at 17 percent.

Underground Injection: Another industrial waste disposal method is the underground injection of wastes into aquifers. Since May 1985, any aquifer used for waste disposal must not be hydrologically linked to an aquifer containing usable water. However, before that time, the disposal of hazardous wastes into shallower wells was permitted. In 1984, the EPA estimated that 60 percent of the approximately 15.6 billion gallons of hazardous waste disposed was injected into deep wells. These wastes are organic solvents, corrosive, reactive and radioactive wastes and brine.

On-Site Sewage Disposal: Approximately 25 percent of U.S. households dispose of their residential wastewater through septic systems, cesspools or other on-site methods. According to one estimate based on a 50-gallon per-day discharge per household, this translates into 3.5 billion gallons of waste daily. In areas where drinking water wells and septic tanks are located near each other, contamination of the drinking water well by the septic tank can occur. Whatever is flushed "down the drain" can then be found in the well water, including pathogenic bacteria and viruses, nitrates, phosphates (detergents) and a variety of household chemicals.

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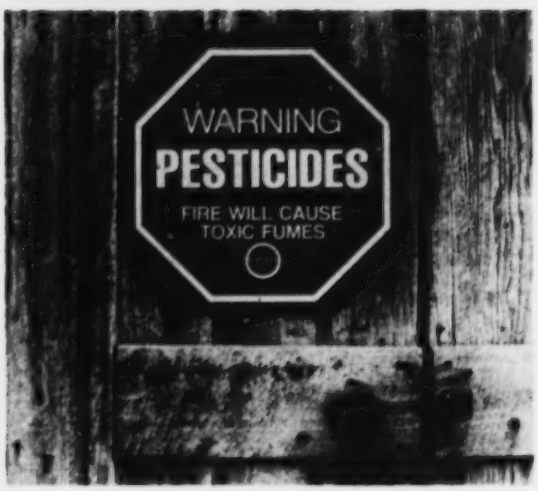

Direct Discharges into Waterways: Since the beginning of civilization, wastes have been disposed in rivers and streams, which have the capacity to dilute and transport them to great distances, or in lakes, which have great capacity to assimilate them. The Clean Water Act of 1972 restricted some industrial discharges into waterways, but this ancient waste disposal method, also known as the "dilution is the solution to pollution" method, is still common practice. In some areas, the waterway that carries away one city's wastes serves as another city's water supply further downstream.

In addition to these identified waste sources, drinking water contamination also can result from agricultural activities, leaking chemical and petroleum storage tanks, accidental chemical spills, runoff or seepage of lawn care chemicals and street salts, naturally occurring radioactive substances, and disease-causing bacteria, protozoa and viruses.

Agriculture: The leaching of dissolved agricultural chemicals (pesticides, herbicides, insecticides and fertilizers) as well as bacteria and nitrates from animal wastes can threaten aquifers and individual wells. Runoff of agricultural chemicals and animal wastes also can contaminate surface waters. In 1984, the U.S. Geological Survey reported that of 124,000 wells for which information was available, more than 20 percent had nitrate nitrogen levels exceeding 3 parts per million, the level believed to indicate contamination from human activities.

Irrigation, which in 1980 accounted for 40 percent of the total groundwater used annually in the United States, acts to concentrate natural salts and minerals at the land's surface; rain or irrigation water eventually returns to the groundwater below, containing two to four times as much salt and minerals as the original irrigation water. At certain levels, minerals such as arsenic and selenium can be hazardous to health.

Underground Storage Tanks: EPA estimates there are between three and five million underground storage tanks containing chemicals and petroleum nationwide. Corrosion of these tanks has become a serious threat to groundwater contamination. In fact, EPA reported in June 1986 that approximately 30 percent are leaking.

During Treatment

Disinfection Byproducts: Ironically, the disinfection of water with chlorine during treatment—the single most significant contribution to halting the spread of waterborne disease—also can cause the creation of an unexpected class of contaminants in drinking water. When water containing trace levels of organic compounds (originating either naturally from decaying vegetation or synthetically from the laboratory) is disinfected with chlorine, a class of compounds called trihalomethanes (THMs) can form. The most prevalent member of this class is chloroform, a substance that has been demonstrated to cause cancer in laboratory animals. Currently, EPA has established a drinking water standard for acceptable levels of THMs and requires water suppliers serving more than 10,000 consumers to test for total THMs. Chlorinating the water later in the treatment process rather than as one of the first steps, reducing the amount of chlorine used, or using an alternative disinfectant have been shown to reduce the levels of total THMs.

Disinfection chemicals are only one of four main categories of chemicals used in the treatment of drinking water. Any substance that is added to or is used in contact with drinking water (such as treatment chemicals, tanks and pipes) is considered a "drinking water additive" and is currently the focus of health study by the National Sanitation Foundation.

After Treatment

Contaminants in the Distribution System: The distribution system is the maze of pipes that carries the treated water from the treatment plant to consumers' taps. Along the way, water can be exposed to a number of contaminants, including bacteria (entering pipes at cracks or leaks, or from "cross connections" between pipes carrying potable water and pipes carrying waste water), metals (lead, copper and iron which may dissolve from pipes into the water, and iron or rust particles from old unlined cast-iron pipes), and vandalism.

What Types of Contaminants Can Threaten Public Health?

"Pure water—that is, water consisting only of water molecules—does not and cannot exist in nature. Nature simply will not allow it to exist . . . the properties which make it a 'universal solvent' cause it to aquire 'impurities' from virtually every natural feature with which it comes in contact."
James Wilson
The Inorganic Constituents of Natural Water

While water can naturally contain bacteria and viruses, salts, minerals, radioactive and organic compounds, these substances are not necessarily safe for consumption and must be removed or reduced to safe levels during the treatment process. The many different contaminants identified in drinking water can be divided into four major categories. (See Figure 2 for existing drinking water standards for these contaminants.)

Microbiological contaminants include a diverse array of bacteria, viruses and parasites that cause and spread disease through water. For example, the Salmonella bacteria that is often present in sewage can cause typhoid. Shigella and Vibrio viruses are associated with severe gastrointestinal illness. Hepatitis A, also transmitted through water, is caused by a virus. A parasitic protozoa that is considered responsible for the majority of gastrointestinal illness today is Giardia lamblia. Coliform bacteria (E. Coli) are used as an indicator organism to test for the presence of fecal matter in water. While harmless themselves, their presence indicates that other, more harmful organisms may be present.

Inorganic chemicals are metals, salts and other chemical compounds that do not contain carbon. It is the level of total dissolved solids, or inorganic substances, in water that determines whether it is fresh water, salt water or brine. Drinking water that arises from groundwater sources is often rich in minerals aquired from the sediments or rocks through which it has moved. Water rich in such minerals is considered "hard."

The most common inorganic constituents of water are bicarbonate, carbonate, calcium, silica, sulfate, chloride, sodium, magnesium, potassium, nitrate, fluoride, carbonic acid, boron, strontium and iron. The EPA has established levels (standards) considered to be safe for the following inorganic chemicals that may be present in drinking water and may threaten health: arsenic, barium, cadmium, chromium, flouride, lead, mercury, nitrate, selenium and silver. As an example, nitrate, which occurs naturally at low levels from the decomposition of vegetation or at high levels due to human activity or geologic deposits, can interfere with the ability of the blood of infants to absorb oxygen, a sometimes fatal condition known as "blue baby syndrome" or methemoglobinemia and which can be fatal.

Organic chemicals are either natural or synthetic chemical compounds that contain carbon. The first organic compounds were synthesized in the laboratory at the turn of the century. These synthetic organic chemicals (SOCs) are now universally used products, including pesticides, solvents (degreasers, for example), paint, dyes, plastics and food additives. A subcategory of organic chemicals, volatile organics (VOCs), evaporate easily under normal conditions and are increasingly being discovered in drinking water supplies. The most commonly found VOCs are trichloroethylene, tetrachloroethylene, 1,1,1-trichloroethane, and 1,1-dichloroethane. The most common sources of organic contamination of drinking water are pesticides and herbicides, industrial solvents, the byproducts produced in disinfecting water (trihalomethanes), petroleum products and chemicals from leaking underground storage tanks.

Radiological contaminants, also termed radionuclides, can enter water naturally from some soils, from the leaching of radioactive wastes or from the mining of phosphorous. If radon, a naturally occurring radioactive gas, is present at high levels in tap water, it may be released into homes and inhaled when the water is agitated during activities such as showering and dishwashing. Radionuclides are demonstrated carcinogens in humans.

Figure 2
Primary Drinking Water Standards

Contaminant	Health Effects	MCL(mg/L)	Sources
Microbiological			
Total Coliforms (Coliform bacteria, fecal coliform, streptococcal, and other bacteria)	Not necessarily disease-producing themselves, but coliforms can be indicators of organisms that cause assorted gastroenteric infections, dysentery, hepatitis, typhoid fever, cholera, and others; also interfere with disinfection process.	1 per 100 milliliters	human and animal fecal matter
Turbidity	Interferes with disinfection	1–5tu	erosion, runoff, discharges
Inorganic Chemicals			
Arsenic	Dermal and nervous system toxicity effects	.05	geological, pesticide residues, industrial waste and smelter operations
Barium	Circulatory system effects	1	
Cadmium	Kidney effects	.01	geological, mining and smelting
Chromium	Liver/kidney effects	.05	
Lead	Central and peripheral nervous system damage; kidney effects; highly toxic to infants and pregnant women	.05	leaches from lead pipe and lead-based solder pipe joints
Mercury	Central nervous system disorders; kidney effects	.002	used in manufacture of paint, paper, vinyl chloride, used in fungicides, geological
Nitrate	Methemoglobinemia ("blue-baby syndrome")	10	fertilizer, sewage, feedlots, geological
Selenium	Gastrointestinal effects	.01	geological, mining
Silver	Skin discoloration (Argyria)	.05	geological, mining
Fluoride	Skeletal damage	4	geological, additive to drinking water, toothpaste, foods processed with fluoridated water
Organic Chemicals			
Endrin	Nervous system/kidney effects	.0002	insecticide used on cotton, small grains, orchards (cancelled)
Lindane	Nervous system/liver effects	.004	insecticide used on seed and soil treatments, foliage application, wood protection
Methoxychlor	Nervous system/kidney effects	.10	insecticide used on fruit trees, vegetables
2,4-D	Liver/kidney effects	.1	herbicide used to control broadleaf weeds in agriculture, used on forests, range, pastures, and aquatic environments
2,4,5-TP Silvex	Liver/kidney effects	.01	herbicide, cancelled in 1984
Toxaphene	Cancer risk	.005	insecticide used on cotton, corn, grain
Benzene	Cancer	.005	fuel (leaking tanks), solvent commonly used in manufacture of industrial chemicals, pharmaceuticals, pesticides, paints and plastics

Contaminant	Health Effects	MCL(mg/L)	Sources
Carbon tetrachloride	Possible cancer	.005	common in cleaning agents, industrial wastes from manufacture of coolants
p-Dichlorobenzene	Possible cancer	.075	used in insecticides, moth balls, air deodorizers
1,2-Dichloroethane	Possible cancer	.005	used in manufacture of insecticides, gasoline
1,1-Dichloroethylene	Liver/kidney effects	.007	used in manufacture of plastics, dyes, perfumes, paints, SOCs
1,1,1-Trichloroethane	Nervous system effects	.2	used in manufacture of food wrappings, synthetic fibers
Trichloroethylene (TCE)	Possible cancer	.005	waste from disposal of dry cleaning materials and manufacture of pesticides, paints, waxes and varnishes, paint stripper, metal degreaser
Vinyl chloride	Cancer risk	.002	polyvinylchloride pipes (PVC) and solvents used to join them, industrial waste from manufacture of plastics and synthetic rubber
Total trihalomethanes (TTHM) (chloroform, bromoform, bromodichloromethane, dibromochloromethane)	Cancer risk	.10	primarily formed when surface water containing organic matter is treated with chlorine
Radionuclides			
Gross alpha particle activity	Cancer	15 pCi/L	radioactive waste, uranium deposits
Gross beta particle activity	Cancer	4 mrem/yr	radioactive waste, uranium deposits
Radium 226 & 228 (total)	Bone cancer	5 pCi/L	radioactive waste, geological

Secondary Drinking Water Standards

Contaminant	Effect
pH	Water should not be too acidic or too basic; must fall between 6.5 and 8.5 on the pH scale.
Chloride	Taste and corrosion of pipes.
Copper	Taste and staining of porcelain
Foaming agents	Aesthetic
Sulfate	Taste and laxative effects.
Total dissolved solids (hardness)	Taste and possible relation between low hardness and cardiovascular disease; also an indicator of corrosivity (related to lead levels in water); can damage plumbing and limit effectiveness of soaps and detergents.
Zinc	Taste
Fluoride	Dental fluorosis (a brownish discoloration of the teeth)
Color	Aesthetic
Corrosivity	Aesthetic and health related (corrosive water can leach pipe materials, such as lead, into the drinking water)
Iron	Taste
Manganese	Taste
Odor	Aesthetic

Source: Environmental Protection Agency

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From the Source to the Tap: How Water Is Made Drinkable

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Public Water Systems

The Safe Drinking Water Act applies to all *public* water systems—that is, all systems, publicly or privately (investor) owned, that serve an average of at least 25 people at least 60 days a year. (The SDWA's requirements *do not* apply to private wells.) Public water systems are classifed into two different categories, depending on whether they primarily serve residents or whether they serve intermittent users.

Noncommunity systems serve travelers and intermittent users. Examples include hotels, restaurants, campgrounds, service stations and other public accommodations that have their own water systems and have at least 15 service connections or serve water to a daily average of 25 people. Currently there are approximately 140,000 noncommunity water systems in the United States.

Community Water Systems have at least 15 service connections used by year-round residents or serve at least 25 year-round residents. Currently there are about 60,000 community water systems in the United States. The smallest of these systems (serving 25–500 people) supply drinking water to more than 60 percent of the total population. (See Figure 3.)

In a community water system, raw water, whether from surface or underground sources, is treated before it reaches your tap. While treatment methods vary depending on the size of the system and local variations in the quality of the water source, the following is an overview of the methods most commonly used in treating drinking water. (See Figure 4 for illustration.)

The Water Treatment Process

by Rosalie Bock
Former manager of youth education for the American Water Works Association

The water treatment process begins with choosing the highest quality source available. There is no "pure" water in nature, because by its very composition water dissolves just about anything that comes in contact with it. Therefore, a careful study of the quality of raw water is a necessary first step. The source of drinking water can be surface water, such as rivers or lakes, or groundwater from deep beneath the surface of the earth.

Raw water must be transported from the source to the treatment plant. Groundwater usually is pumped directly into the plant, where in many cases the only treatment necessary is disinfection before the water is distributed through a pipe network to consumers. Groundwater is naturally filtered as it seeps down through layers of rock and soil; however, it sometimes needs to be treated to remove specific contaminants that may have percolated down from the surface to the aquifer. In addition, some groundwater must have trapped gasses released from it or some minerals removed to make the water less hard. If groundwater is treated, a process similar to that used to treat surface waters is used.

Surface water is sent to the water treatment plant through aquaducts or pipes. An initial screen at the intake pipe prevents large objects from entering the plant. The water may then be aerated to eliminate trapped gasses and to add oxygen. Once the water is inside the plant, various chemicals are added to begin the cleansing process. Because raw water differs in hardness (the level of natural minerals) and cleanliness, this initial treatment step varies according to the specific quality of the raw water source. Conventional treatment begins with a rapid dispersion of a coagulant, a chemical that causes suspended particles in the water to combine physically to form larger clumps of solids called floc. This chemical is usually a metal salt such as aluminum sulfate or ferrous or ferric chloride, or a synthetic organic polymer. Chemicals also may be added to remove tastes or odors that would make the water unpalatable.

If the water is hard, lime is added to precipitate most of the calcium and magnesium out of the water. For additional removal of calcium, the water can be treated with soda ash. Smaller water systems often soften water by exchanging the calcium and magnesium ions with sodium ions. Hard water can clog pipes with calcium carbonate, stain fixtures and make soap difficult to lather.

An oxidant may be added to the water to break down certain organic compounds and make them easier to remove. Chlorine, also used later in the treatment process as a disinfectant, is the most widely used substance for this purpose. However, it has been

Figure 3
Characterization of Community Water Systems (FY 1985)

	Very Small		Small		Medium			Large			Very Large	TOTAL
Population Served	25–100	101–500	501–1000	1001–2500	2501–3300	3301–5000	5001–10000	10001–25000	25001–50000	50001–75000	75001–100000	Over 100000	
Number of Systems	19,717	18,321	6,254	6,432	1,432	1,980	2,128	1,782	697	230	94	279	59,346
Percent of Systems	33.2	30.9	10.5	10.8	2.4	3.3	3.6	3.0	1.2	0.4	0.2	0.5	100.0
Principle Source													
Ground	18,182	15,858	4,881	4,380	894	1,114	1,164	823	273	70	17	44	47,700
Surface	1,535	2,463	1,373	2,052	538	794	964	959	424	160	78	235	11,151
Ownership													
Public	1,440	7,199	4,944	5,325	1,216	1,644	1,771	1,491	507	187	79	209	25,803
Private	17,986	10,800	1,236	1,064	0	330	356	290	190	43	15	47	32,357
Indian	291	322	74	43	6	6	1	1	—	—	—	—	744
Approximate Population Served													
(Millions)	1.089	4.550	4.646	10.496	4.158	7.831	15.351	28.496	25.034	14.063	8.099	95.409	219.22
(Percent)	0.5	2.1	2.1	4.8	1.9	3.6	7.0	13.0	11.4	6.4	3.7	43.5	100.0

Source: Environmental Protection Agency

found that under certain conditions, chlorine added to the water at this early stage of the treatment process may combine with the organic compounds to form traces of trihalomethanes, the most common of which is chloroform, a probable human carcinogen. Although levels of trihalomethanes are usually present in minute quantities (expressed as parts per billion), their presence constitutes a health concern, and they must be removed if they exceed the drinking water standard. To avoid this problem, some treatment plants are switching to other disinfectants such as chloramines, ozone or chlorine dioxide, or are altering the treatment process to prevent the conditions that cause trihalomethanes to form.

As the coagulants, softeners, odor reducers and oxidants are added, the water is then rapidly mixed to disperse the treatment chemicals evenly. Next, the water is sent to sedimentation basins where the heavy floc (large particles) settles to the bottom and is removed. The water, free of large floc, now travels to filtration beds. The initial screen removed the large objects from the water, the coagulation/flocculation process formed the floc to remove much of the smaller suspended particles, and now, the filtration process—often called "polishing"—removes most of the remaining small particles as well as most of the disease-causing bacteria and viruses*.

In current practice, the water usually settles down through several layers of filtration media. These media usually consist of several grades or sizes of sand and gravel and a layer of anthracite (hard) coal. Substances in the water are held captive by the filter media. Most plants rely on gravity to send the water through the filters, but some smaller utilities use pressure filters that force the water through the filter media, primarily to save space. Because the filtration process leaves particles in the filter media, the filter must be cleaned, or backwashed, at certain intervals. In backwashing, a high flow rate of water is forced upward through the filter media and into backwash water troughs. The backwash water is usually further treated to remove solids, which are eventually disposed of in a landfill. The remaining water is usually retreated as drinking water or discharged into the water source.

Additional treatment may be required if the raw water shows high levels of toxic organic chemicals. These chemicals may result from industrial and municipal discharges, urban and rural runoff or even natural sources. Some of the chemicals are removed by filtering the water through granulated or powdered activated carbon. In this treatment, referred to as granular activated carbon (GAC) the chemicals adhere to the carbon through a process called adsorption. Because these chemicals cannot be removed from the

carbon by backwashing, it is necessary to replace the carbon frequently, or recharge and reactivate the used carbon by burning off the contaminants at very high temperatures. The used carbon is usually recycled for drinking water treatment or another purpose.

If the water contains volatile organic compounds, chemicals that become gases at room temperature, a treatment technique referred to as packed tower aeration (PTA) may be used. In this process water is trickled by gravity down through a tower filled with loose packing material and open to the atmosphere at its top. This process causes the VOCs to transfer from the water to the air; a stream of air blown up through the tower discharges the VOCs to the air or to be captured in activated carbon filters. Radiological contaminants from natural and synthetic nuclear products can be removed during the treatment process if necessary. Uranium is removed during the softening process, while radon can be removed by granular activated carbon or packed tower aeration.

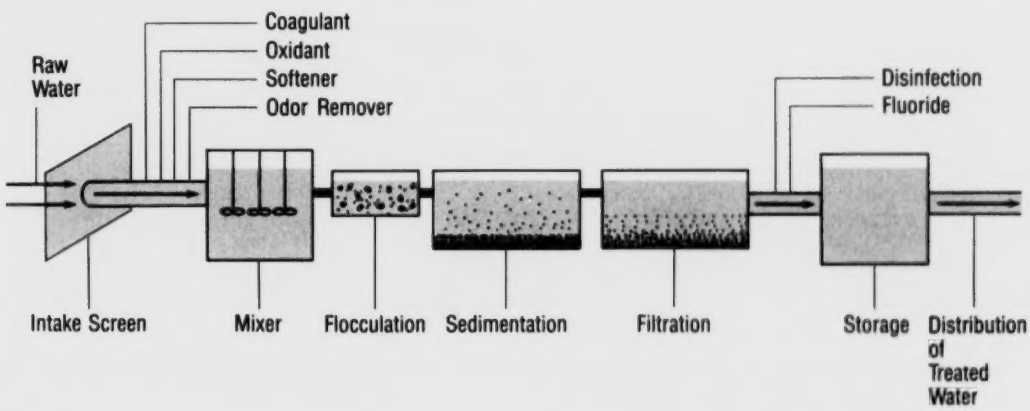
At various points in the treatment process, the water is monitored to assure that it is being properly treated. Computerized systems are used in many large systems to automatically control virtually all treatment steps. Gas chromatograph and mass spectrometer techniques developed in the last ten years are capable of identifying and measuring contaminants in minute quantities—parts per million or parts per billion. (One drop in a full ten gallon aquarium would be about one part per million. The same drop in a swimming pool containing 10,000 gallons of water is about one part per billion.) Due to their great expense however, these analytical techniques are used by few utilities for conventional monitoring purposes.

As the water leaves the treatment plant, chlorine is added as a disinfectant to keep the water free of organisms as it travels through the miles of distribution pipes to customers. It is this disinfection that is responsible for the low incidence of waterborne diseases such as cholera and typhoid that were public health scourges two generations ago. Chlorine is the most widely used disinfectant because it is inexpensive, easily applied and reliable (it is easily measured throughout the distribution system). If not present naturally in the raw water and a community desires it, the treatment plant may add fluoride to help prevent tooth decay in children.

The water then travels from the plant to reservoirs where it is stored until needed. These may be elevated towers, where gravity brings the water to the consumer without any extra energy expenditure, or ground-level containers that may require pumps to move the water through the system. The water that flows from the tap should be *clear*, *tasteless* and *safe* to drink.

*Note: Filtration removes protozoa, bacteria and some viruses. Most viruses, however pass through the filtration process.

Figure 4:
The Water Treatment Process



Source: American Water Works Association

3 The Safe Drinking Water Act In Theory and In Practice

A Brief History of Drinking Water Regulation

In the early part of this century, the federal government, through the U.S. Public Health Service, established the first standards for regulating contaminants in drinking water. These early standards were designed in large part to control bacteria and viruses that can cause waterborne diseases such as typhoid, cholera, hepatitis-A and dysentery. The standards were overwhelmingly successful in curbing the spread of such disease, but 50 years later, new causes of concern began showing up in drinking water: traces of the approximately 65,000 chemicals depended upon in commerce and used in the home as well as in industry. The solutions to turn-of-the-century problems provided little protection against these chemicals.

Recognizing the growing threat of chemical contamination, the U.S. Public Health Service in 1962 revised the national drinking water standards to include limits on organic chemicals. The Environmental Protection Agency (EPA) succeeded the U.S. Public Health Service in administering the drinking water standards and, in 1971, a technical committee of scientists and engineers recommended that EPA tighten the standards for organic chemicals in drinking water. Unfortunately, the recommendations were never adopted, but for the first time the public was alerted to the need for more regulation and tighter control over drinking water systems.

Public attention was next captured by a 1972 EPA report detailing organic chemical contamination in the drinking water supplied to residents of New Orleans from the Mississippi River, the repository for municipal sewerage and industrial discharge over its 2,000 mile course. A follow-up study conducted by the Environmental Defense Fund found that people drinking treated Mississippi River water in New Orleans had a greater chance of developing certain cancers than those in neighboring areas whose drinking water came from groundwater sources.

The heightened public awareness of the threat of drinking water contamination in the early 1970s became a major factor behind the push for congressional action on the issue. The evidence of carcinogens in drinking water established a sense of urgency that led to the signing of the Safe Drinking Water Act into law on December 16, 1974. The law was a major step forward—even though it has not accomplished all it was intended to.

The Safe Drinking Act (SDWA) gave the federal government, through EPA, authority to set specific standards for contaminants in drinking water, to require monitoring for those contaminants, and to require the installation of treatment technologies to cleanse water of unsafe levels of pollutants. While the act gave EPA responsibility for promulgating drinking water regulations, it gave state and local regulatory agencies the opportunity to assume primary responsibility for enforcing those regulations.

The SDWA also initiated a program to protect underground sources of drinking water by regulating underground injection wells and by denying funds to federally assisted projects in areas that had been classified as "Sole Source Aquifer Areas" (those relying on groundwater from one aquifer for at least 51 percent of the water supply) if the projects threatened the aquifer.

Although there are several federal laws that provide varying degrees of protection for drinking water supplies—including the Clean Water Act (CWA); the Resource Conservation and Recovery Act (RCRA); and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as Superfund—the Safe Drinking Water Act is the only federal law designed to deal comprehensively with safe drinking water.

The major provisions of the 1974 SDWA require:

- national standards for regulating levels of contaminants in drinking water;
- uniform guidelines for treatment of drinking water;
- monitoring and reporting requirements for public water systems;
- regulations for underground injection of fluids.

In the decade following the passage of the SDWA, some substantive problems remained—EPA was slow to regulate contaminants and states were lax in enforcing the law. Consequently, in 1986 Congress enacted amendments

designed to close some of the loopholes and begin to gather new knowledge about the quality of community drinking water supplies. The following section discusses the requirements of the 1974 law, its inadequacies, and the requirements of the 1986 SDWA Amendments for getting public water systems back on track toward assuring a safe supply of drinking water. The need for and implementation of the 1986 amendments frame the current issue debate, which is discussed in Chapter Five.

Setting Drinking Water Standards

Primary and Secondary Standards

As required by the SDWA, EPA has established *national drinking water standards*. A standard is the maximum level of a substance that EPA has deemed acceptable in drinking water.

There are two types of drinking water standards:

Primary Standards or MCLs: Primary standards are set for substances that can pose a threat to health when present in drinking water at certain levels. Because these substances are of concern for health (not just aesthetic) reasons, primary standards are *enforceable*. A primary standard also is referred to as a *maximum contaminant level (MCL)*. In July 1987 EPA finalized MCLs for eight volatile organic chemicals bringing the number of primary standards to 30.

Secondary Standards: Secondary standards serve as guidelines in setting levels for aesthetic considerations such as taste or odor. Unlike primary standards, secondary standards are recommended levels only and are *nonenforceable*. EPA has established 13 secondary standards.

In setting a primary standard for a drinking water contaminant, EPA, in consulation with the National Academy of Sciences, first reviews the human and animal health effects data for the particular substance in question. EPA next proposes a *nonmandatory maximum contaminant level goal (MCLG)* (before the 1986 amendments this was referred to as a Recommended Maximum Contaminant Level). At the same time, EPA proposes a *mandatory* primary drinking water standard, a maximum contaminant level (MCL) which, based on technological and economic considerations is set as close to the MCLG as is feasible. The important difference between the two is the MCLG is a nonenforceable *goal* and the MCL is an enforceable *standard*. Following a period for public comment on the proposed MCL, it becomes law. States must adopt the standard within 18 months of enactment. For more information on how standards are set, see Chapter Five. Figure 2 lists the current primary standards and the health concerns associated with the contaminants.

Drinking water standards are set at different levels for community and noncommunity systems. Since water from community systems may be consumed daily over a long period of time, the health effects of both long- and short-term exposure to contaminants must be taken into account in these systems. In noncommunity systems, where water is consumed occasionally or for short periods of time, the focus of regulation is on the short-term exposure to contaminants.

States that have adopted drinking water regulations at least as stringent as those set by EPA are given responsibility for enforcing the primary standards, or MCLs. This delegation of enforcement authority is referred to as *primacy*. In areas that have not assumed primacy (the District of Columbia and the states of Indiana and Wyoming), EPA has responsibility for enforcing the primary standards. States may set more stringent standards or establish standards for contaminants not regulated by EPA.

EPA's Track Record in Setting Standards

"Seven hundred organic, inorganic, biological and radiological contaminants have been detected in the drinking water supplies of the United States. And yet today after 12 years under the Safe Drinking Water Act we have standards for only 23 contaminants, and two-thirds of those were established by the Public Health Service in the 1960s."
Senator David Durenberger (R MN)
1986 Reauthorization of the Safe Drinking Water Act

Since standards have been set under the SDWA for only 30* contaminants to date, a drinking water system that meets the federal requirements (MCLs) could still be delivering water contaminated by unregulated substances. In addition, advances in analytical testing capabilities and our understanding of the health risks from both long- and short-term exposure to contaminants have caused doubts that the current drinking water standards are adequate for protecting public health.

Because of EPA's slow pace in setting primary standards, Congress legislated a strict timetable and list of contaminants to substantially hasten the process. The 1986 SDWA amendments require EPA to set primary standards for 53 additional contaminants in drinking water within three years of enactment (by June 1989). The amendments also require EPA to review and possibly revise the existing standards.

The schedule specifically requires EPA to set primary standards for 49 of the 83 contaminants by June 1988 and for the remaining 34 by June 1989. (Figure 5 lists the contaminants that EPA will regulate by June 1989.)

Health Advisories: Filling the Gap

For contaminants for which no standards have yet been set, EPA issues health advisories that specify levels above which the contaminants might cause health risks. While health advisories are available to the public, they are not intended for use by citizens to make decisions regarding risks to their health; they are used by scientists and water quality managers as technical guidance in evaluating the health effects of various concentrations of contaminants in drinking water and in making decisions regarding what actions to take.

Unlike drinking water standards, health advisories are not legally enforceable; but like standards, they are subject to change as new and better information becomes available. To date, final health advisories have been developed for 49 contaminants, with additional health advisories for 50 pesticides and 40 volatile organic chemicals nearly final. The EPA has developed a *Citizen's Guide to Health Advisories* (See Resources Section).

*Note: Before July 1987, EPA had set 22 standards. New standards set for eight VOCs bring the total to 30.

Fluoride: A Contaminant of Cosmetic or Health Concern?

Fluoride, in the form of sodium fluoride or hydrofluosilic acid, was first added to drinking water in 1945 to prevent tooth decay. Although little is known about the long-term health effects of exposure to fluoride, it is generally accepted that at levels near 1 part per million (ppm) in drinking water fluoride does its job well. At levels of 2 ppm and greater fluoride may cause dental flurosis (discoloration and mottling of the teeth, especially in children), and that at levels of 6–8 ppm, it may cause skeletal flurosis (brittling of the bones and stiffening of the joints). Is dental flurosis an adverse health effect? EPA recently reclassified dental fluorosis as a cosmetic effect, raised the primary drinking water standard from 1.4–2 ppm to 4 ppm, and established a secondary standard of 2 ppm for fluoride. This move stirred controversy among many (including some EPA scientists) who believe that allowable concentrations are too high, especially considering other common sources of fluoride consumption such as toothpaste, beverages and foods prepared with fluoridated water. Some also believe that EPA revised the fluoride standard at the urging of states with high natural levels of fluoride in drinking water.

Monitoring Drinking Water Quality

To ensure the consistency and safety of drinking water, the SDWA requires utilities to conduct routine monitoring and testing of public water supplies. The monitoring requirements are very specific. All public water systems are required to test on a prescribed schedule for pollutants for which standards have been set. Monitoring and testing must be conducted in accordance with standard analytical testing procedures.

Two types of sampling are required. *Routine sampling* takes place on a regular basis and ensures that a treatment plant is running properly and delivering a consistent quality of drinking water. When a routine sample analysis indicates elevated levels of a particular contaminant that exceed the EPA or state standard, check sampling is required. *Check sampling* is used to confirm the results of a problem discovered during routine sampling.

Community water systems must test for the 30 types of contaminants for which EPA has set MCLs, whereas noncommunity systems, which

Figure 5
Contaminants To Be Regulated by EPA by June 1989*

Microbiological Contaminants		
Turbidity*	Viruses	
Total Coliforms*	Standard Plate Count	
Giardia lamblia	*Legionella*	
Volatile Organic Chemicals		
Trichloroethylene*	Vinyl Chloride*	Trichlorobenzene(s)
Tetrachloroethylene	Methylene Chloride	1,1-Dichloroethylene*
Carbon Tetrachloride*	Benzene*	cis-1, 2-Dichloroethylene
1,1,1-Trichloroethane*	Chlorobenzene	trans-1, 2-Dichloroethylene
1,2-Dichloroethane*	Dichlorobenzene(s)*	
Synthetic Organic Chemicals		
Endrin*	Carbofuran	Pentachlorophenol
Lindane*	1,1,2-Trichlorethane	Picloram
Methoxychlor*	Vydate	Dinoseb
Toxaphene*	Simazine	Alachlor
2,4,-D*	PAHs (Polynuclear Aromatic	EDB (Ethylene Dibromide)
2,4,5-TP (Silvex)*	Hydrocarbons)	Epichlorohydrin
Total Trihalomethanes*	PCBs (Polychlorinated	Dibromomethane
Aldicarb	Biphenyls)	Toluene
Chlordane	Atrazine	Xylene
Dalapon	Phthalates	Adipates
Diquat	Acrylamide	Hexachlorocyclopentadiene
Endothall	DBCP (Dibromochloropropane)	2,3,7,8-TCDD (Dioxin)
Glyphosate	1,2-Dichloropropane	
Inorganic Chemicals		
Arsenic*	Silver*	Vanadium
Barium*	Fluoride*	Sodium
Cadmium*	Aluminum	Nickel
Chromium*	Antimony	Zinc
Lead*	Molybdenum	Thallium
Mercury*	Asbestos	Beryllium
Nitrate (as N)*	Sulfate	Cyanide
Selenium*	Copper	
Radiological Contaminants		
Radium 226 and 228*	Beta Particle and Photon	Natural Uranium
Gross Alpha Particle Activity*	Radioactivity*	Radon

*asterisked substances are currently regulated; all except the VOCs may be revised.
Source: Environmental Protection Agency

serve only occasional users, must test only for bacteria and nitrate. All systems relying on surface water for their supply also must test for turbidity. There are no federal testing requirements for private wells although some state and local governments do have regulations governing testing. (See Figure 6 for monitoring requirements.)

Parts Per Million . . . Parts Per Billion ?

Most impurities in water are measured in parts per million. One part per million is one part of the substance measured in a million parts of water. In scientific terms, parts per million (ppm) and parts per billion (ppb) refer to the number of milligrams (mg) or micrograms (ug) of substance per liter of water, that is mg/L or ug/L. A part per million is 1,000 times greater than a part per billion.

No testing method has been developed that is sensitive enough to determine with absolute certainty that a certain pollutant is not present in a water supply. The concept of zero degree of contamination does not exist. If laboratory equipment is not sensitive enough to be able to detect the presence of a chemical below a certain base level, the result may appear on test results as ND, meaning "not detected."

The Track Record of Public Water Supply Systems

While most large systems are equipped to meet the requirements of the SDWA, almost 35 percent of community water systems, particularly smaller systems, have been cited for failure to meet established MCLs and the monitoring and reporting requirements. A 1981 study by the General Accounting Office (GAO) of compliance with the SDWA found widespread instances of violations involving 28,000 of the 65,000 community water systems nationwide.

Even as recently as 1985 EPA estimated that 1,300 community systems might be in violation of the proposed MCLs for volatile organic chemicals (VOCs). While many of the larger systems, as a matter of course, monitor for a wide range of contaminants, many small communities lack the financial resources and technical expertise to

Figure 6
The Monitoring Requirements of Public Water Systems

What Tests	Where Samples Taken	How Often (Community System)	How Often (Noncommunity System)
Inorganics	At the consumer's faucet	Systems using surface water every year Systems using groundwater only: every 3 years	State option except for nitrate
Organics: except THMs	At the consumer's faucet	Systems using surface water every 3 years Systems using groundwater only: state option	State option
Organics: THMs	25 percent at extremes of distribution system: 75 percent at locations representative of population distribution	Systems serving populations of 10,000 or more: 4 samples per quarter per plant	State option
Volatile Organics	At point(s) where water enters the distribution system	Quarterly samples for first year, then variable	State option
Turbidity	At the point(s) where water enters the distribution system	Systems using surface water: daily Systems using groundwater only: state option	Systems using surface or surface and groundwater only: daily Systems using groundwater only: state option
Coliform bacteria	At the consumer's faucet	Depends on number of people served by the water system	Systems using surface and/or groundwater: 1 per quarter (for each quarter water is served to public)
Radiochemicals: natural	At the consumer's faucet	Systems using surface water: every 4 years Systems using groundwater only: every 4 years	State option
Radiochemicals: man-made	At the consumer's faucet (at state option)	System using surface water serving populations greater than 100,000: every 4 years All other systems: state option	System using surface and/or groundwater: state option

Source: American Water Works Association

adequately comply with the intent of the act. Most small communities cannot afford to hire fully qualified personnel to run the treatment system and many rely on the efforts of a volunteer or part-time operator who has little training to ensure the proper operation of the treatment system.

The 1986 amendments require EPA to enforce Safe Drinking Water Act requirements when a state does not take appropriate enforcement action within 30 days after being notified by the community water system that a violation has occured. Citizens are given the ability to bring suit against EPA or the state if enforcement is not taken.

Monitoring for Unregulated Contaminants

Monitoring for contaminants—other than those for which EPA has set standards—was not required by the SDWA of 1974. To date, any monitoring of unregulated contaminants has been initiated by a state or a public water system. According to GAO estimates, only 16,000 of the more than 60,000 public water systems have tested their supplies under official testing programs for any contaminants other than the 30 presently regulated.

Pesticide contamination is one area of major concern, especially because current drinking water standards include only six pesticides. In a 1985 study of pesticides in groundwater, EPA reported that 17 pesticides, none of which are currently regulated by the national primary drinking water standards, were detected in the groundwater of 23 states.

Wisconsin, Minnesota, Florida and California, among other states, have initiated programs to monitor groundwater sources of drinking water for unregulated contaminants. In Wisconsin, 25 percent of 208 public water supply wells, serving 28 of the state's largest communities, showed detectable levels of at least one synthetic organic chemical.

In an attempt to begin assessing the full extent of drinking water contamination, the 1986 SDWA Amendments emphasize monitoring for unregulated contaminants. Specifically, the amendments require EPA, by January 1988, to establish a list of substances known or anticipated to occur in drinking water. This list is to be independent of the 57 substances for which EPA must set standards over the next three years. All community water systems will be required to monitor at least once every five years for the substances on this list.

The costs of monitoring, especially for such a wide range of pollutants, is very expensive and difficult for small water systems to contemplate. Congress attempted to ensure that small systems would be able to afford this monitoring by authorizing $30 million in federal funds for sampling and analysis exclusively for small systems. However, no funds were actually allocated in fiscal year (FY) 1987 and none are anticipated in 1988. Small systems supplying fewer than 150 service connections are allowed to meet monitoring requirements by submitting a water sample to the state or EPA for testing, or allowing the state or EPA to take their own samples.

Record Keeping

Public water systems are required to maintain records of sample analyses and make them available for public inspection. Bacteriological analyses records must be kept for at least five years; results of chemical analyses must be kept for ten years.

Records may be kept in the form of actual laboratory results or the data may be transferred to tabular summaries. The information should include:

- the date, place and time of sample and the name of the person sampling;
- identification of the sample as a routine, check, or raw water sample;
- the date the sample was analyzed;
- the name of the laboratory and the person responsible for performing the analysis;
- the analytical technique or method used;
- results of the analyses;
- records of action taken by the public water system to correct the problem if the sample indicated a violation of primary drinking water regulations.

Reporting Water Quality and Notifying the Public of SDWA Violations

Public water systems are required to submit reports to the state detailing the results of monitoring and testing. Routine sampling results for community water systems are reported on a monthly basis. If a public water system fails to comply with any primary drinking water regulation, which can include failure to comply with monitoring and testing requirements, then the system operators, in most cases, must report the violation to the state within 48 hours. Noncommunity systems must report monitoring results at intervals specified by the state.

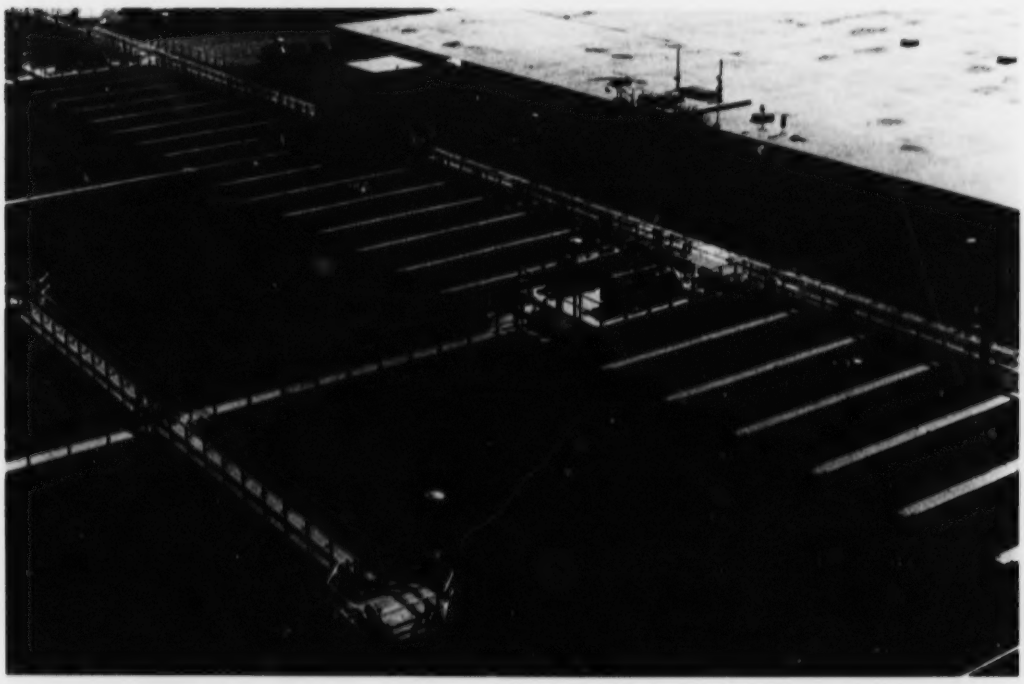
If a public water system is performing inadequately and fails to meet the applicable MCLs or the required testing and monitoring schedule, the supplier *must* notify its customers that a violation has occurred. It is important to note that a public water system is considered to be in violation of the MCLs only if a routine sample *and* additional check samples confirm that an MCL has been exceeded.

If a violation results in failure to comply with approved testing procedures or failure to perform any required monitoring, or when a variance or exemption has been granted to the system, the supplier is required to notify its customers of the failure by a written notice in the next water bill or within three months. The notice must be repeated every three months as long as the problem or variance continues.

In addition, if the problem results in a violation of an MCL, the system is required to notify the public by publishing a public notice not less than three consecutive days in a newspaper(s) of general circulation in the area served by the system. The notice must occur within 14 days after the utility learns of the problem. A copy of the notice must also be given within seven days to radio and television stations serving the area.

In a 1981 study, the U.S. General Accounting Office found that of 146,000 violations reported in 1980, the public was notified in only 16,000 cases.

For noncommunity systems that fail to meet the MCLs, the state determines the form of notice ensuring that the public using the system is adequately informed. As directed by the 1986



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SDWA Amendments, EPA has proposed revisions to the public notification process to ensure that the public is notified of serious violations within 14 days.

Filtration and Disinfection of Water

The incidence of waterborne contaminants such as bacteria and viruses, which had been declining for decades, has shown a resurgence in recent years. In 1983, 40 outbreaks caused illness in 21,000 individuals. The causes are multifaceted; while modern water treatment technology and antibiotics have eradicated life-threatening waterborne disease, public health advancements in linking micro-organisms carried in water to human illness, as well as increased reporting, have made it clear that we have not conquered all "traditional" contaminants. And despite advancements in our knowledge, the causes of half of all reported waterborne disease outbreaks still remain a mystery to health officials.

The most commonly identified pathogen in outbreaks of waterborne disease in the United States today will not kill you, but it will make you very uncomfortable (abdominal cramps, diarrhea, fatigue, weight loss, nausea, vomiting) and perhaps give you a long-term infection. The culprit is a parasitic protozoan, Giardia lamblia. Most community water systems are not equipped to remove Giardia from water. At one stage of Giardia's four-stage life cycle, it takes the form of an infective cyst. These cysts can survive in water up to two months, are resistant to chlorine and easily pass through the filters of most water treatment plants due to their small size.

The 1986 SDWA Amendments have renewed the battle against microbiological contaminants in drinking water by requiring EPA to specify criteria by 1988 for filtration of surface water for public water systems using surface water supplies, and by 1990 to specify criteria for disinfection of groundwater for public water systems using groundwater supplies.

Groundwater (Wellhead) Protection

The 1974 SDWA defined "sole-source aquifers," that is, aquifers supplying at least 51 percent of a community's drinking water supply, as unique and critical aquifers deserving the highest level of protection. However, no single federal regulation was ever developed requiring protection of sole-source aquifers. A number of states did use the designation to initiate programs for the protection of sole-source aquifers (in Cape Cod, Massachusetts and Spokane, Washington, for example).

Under the 1986 SDWA Amendments, states are directed to develop strategies within three years for protecting wellheads—the areas surrounding wells that supply public drinking water. States submitting plans are eligible to receive federal funding for implementation. There is no penalty for states that do not submit plans to EPA. EPA is required to provide technical assistance in designing plans for land use in wellhead areas, but the state is responsible for determining the extent of the area to be protected and for specifying the management responsibilities of state and local government and water systems in protecting wells. Congress authorized $8 million for the program in FY 1988.

To protect wells that are also sole-source aquifers, the 1986 SDWA Amendments established the Sole Source Aquifer Demonstration Program. This program would provide up to 50 percent of the cost of developing and implementing sole-source aquifer protection plans to state, local or city governments. Congress authorized $10 million in FY 1987, $15 million in FY 1988, and $17.5 million for each of fiscal years 1989 through 1991. However, no funds were actually allocated for this program in FY 1987.

Lead Contamination of Drinking Water

The 1986 SDWA Amendments address recent scientific findings that lead contamination is a major problem in both public and private water systems and that drinking water is, in many areas, the major route of exposure to lead. The 1974 act did not include provisions to regulate lead contamination.

Under the 1986 amendments, the use of solder and flux containing more than 0.2 percent lead is prohibited, and pipes containing more than 8 percent lead in new installations and repairs of public water systems are banned. State and local governments have until June 1989 to ensure that building and plumbing codes reflect this ban. Within two years of enactment, by June 1988, utilities with customers who may be at risk because of lead contamination sources in drinking water must provide public notification of potential lead contamination.

In spring 1987, EPA proposed that *all* public water supply operators, regardless of whether they are violating the MCL for lead, must notify their customers by June 1988 of any potential sources of lead, adverse health effects of lead, available methods for reducing known or potential lead content and any need to seek an alternate water supply. Following the initial notification, utilities would be required to provide notification on lead once every five years.

EPA also has indicated that following its review of the adequacy of the existing standard for lead in 1987, the agency will propose lowering the MCL from 50 parts per billion to at least 20 parts per billion.

The Safe Drinking Water Act: What Is in It for Consumers

by Ralph Nader
Consumer Advocate

Twenty of the contaminants that EPA will be regulating over the next three years have already had standards established, but they will be reviewed and possibly revised under the 1986 amendments. For each standard set, regular testing by each water supplier for the presence of that contaminant is required. In fact, by December 1990, this requirement will apply to every public water supplier in the United States. In many communities, the results of this testing will present the first evidence of drinking water contamination by industrial and agricultural chemicals.

Compliance with SDWA

Since 1980, 35 percent of all public water systems have been consistently out of compliance with the current minimal federal monitoring and reporting requirements. As more standards are set, the compliance problem could worsen as systems lag behind standards in updating their testing capability and treatment technology to remove contaminants found in the testing. On a local level, consumers can take a large responsibility for ensuring that their community water supplier completes testing as required. Public notification in community newspapers is required by the Safe Drinking Water Act for any violation of a maximum contaminant level that poses a serious potential adverse health effect. Consumers can ensure that notification includes:

1. a clear explanation of the violation;
2. any potential adverse health effects;
3. steps that the system is taking to correct the problem and;
4. the necessity, if any, for seeking alternative water supplies.

Water suppliers are subject to a fine of up to $25,000, assessed by the EPA administrator, if they do not comply with public notification requirements to be set out by the administrator by December 1987. Consumers also can ensure that their community water supplier takes actions such as installing treatment technology to remove any contamination that is detected at significant levels. This will be a major first step in the process towards finally ensuring safer drinking water supplies across the United States.

Testing for Unregulated Contaminants

In total, only about 16,000 of the more than 60,000 public water systems in the U.S. have been tested under official state testing programs for any contaminants other than the those presently regulated. The last national drinking water survey, the Groundwater Supply Survey, was completed in 1980 and since then only a limited number of systems in 35 states have

been tested for a limited number of unregulated contaminants. Contamination by more than 100 chemicals in total has been found in more than 2,200 systems spread across all of these 35 states. Fifteen states have not tested any of their water supplies for any unregulated contaminants. Public water systems in these states and the 13 states that have not tested their water systems for unregulated contaminants since January 1, 1983 are required, under the 1986 amendments, to test for a proposed list of 51 contaminants some time after the testing criteria is set out by the administrator on or before December 19, 1987. Again, consumers can ensure that their community water supplier completes this required testing for unregulated contaminants and takes action such as installing treatment to remove any contaminants found.

For each standard established, the EPA administrator is required to list the technology, treatment techniques and other means that are found to be feasible for removing the contaminant to levels below the standard. Many water systems will be forced to either shut down wells or update their treatment facilities in order to meet the standards if initial tests uncover contamination problems. Only 50 out of the more than 60,000 public water systems currently utilize technology (granular activated carbon and/or packed tower aeration) capable of removing the substances to be regulated over the next three years. Only two large population centers, Cincinnati and Los Angeles, both faced with serious contamination problems, have proposed to install this necessary treatment technology.

Between 1977 and 1980, the EPA tested seven cities' drinking water supplies for all organic contaminants. The testing found more than 150 contaminants in each city's water supply and detected a total of more than 1,300 chemicals. In this and other testing that has occurred since the Safe Drinking Water Act was enacted in 1974, a total of more than 2,100 substances have been detected in U.S. drinking water supplies. Only 10 percent of these substances have been adequately tested to establish their possible health effects on humans.

The serious health hazard posed by lead contamination was partially addressed in the amendments by a federal ban, which comes into effect in June 1988, on the use of lead solder, flux and piping in plumbing systems. However, the problem of lead leaching into drinking water from existing lead piping and solder remains. Current federal monitoring standards do not require water suppliers to test for lead content of household tap water samples, where the contamination is at its highest levels. Test samples are usually taken at the water treatment plant so maximum allowable levels are usually not exceeded.

States and regional EPA offices are authorized to enforce the lead standard of 50 micrograms per liter (ug/L) when presented with reliable evidence of lead levels exceeding the standard. If tests of your tap water show lead levels above the standard, you should contact the state and EPA drinking water offices and request that enforcement action be taken.

The Costs of Upgrading Treatment Plants

When compared to the average cost of 80¢ for a gallon of bottled water, the costs to consumers of updating drinking water treatment plants are minimal. In Cincinnati, utility rates will rise 22 percent, from 90¢ to $1.10 per thousand gallons, when the planned activated carbon system is installed. In 12 of the 24 systems updated with air-strippers, there was no increase in the price of the water. In six cases, polluting industries were forced under court settlements to pay for the treatment technology. State and federal Superfund monies paid for two other systems. In three other cases, costs increased only about 10¢ per thousand gallons of treated water. As contamination is detected by increased testing over the next three years, polluting industries should be forced to pay for adequate treatment to remove the contamination. If this is not possible, effective treatment technology should still be installed by the water supplier. This treatment has been proven to be affordable for systems large and small over the past six years.

Generally, the new amendments are going to make drinking water more expensive for the consumer as investments are made in testing and treatment technology. Costs also may increase if the mismanagement of water resources continues and scarcity ensues. It is in consumers' interest to take an active role in the response to contamination, and the installation of treatment technology to protect their community from further contamination. The time, energy and funding that will be invested in our drinking water resources over the next few years should result in cleaner and safer drinking water that reduces the risks of cancer and other diseases across the United States.

4 Who Is Responsible?

The Environmental Protection Agency is the principal federal agency that oversees the nation's drinking water programs. EPA is responsible for setting drinking water standards and writing regulations, while state agencies are responsible for enforcing drinking water standards and in implementing federal regulations. Locally, decisions affecting land use through ordinances and bylaws can directly serve to improve or degrade local drinking water quality.

The LWVEF asked representatives at the federal, state and local levels to discuss the most important challenges facing them in fulfilling their roles in assuring safe drinking water. This chapter includes a discussion of EPA's role by Michael Cook, Director of the Office of Drinking Water; a view of the state role by James Pluntze, former Director of the Washington State Public Water Supply Program; and a local perspective by Ward Welsh, Vice-President of the American Water Works Service Company.

The Federal Role

As the principal federal agency charged with overseeing the nation's drinking water programs, EPA:

- sets federal drinking water standards;
- enforces the standards by periodic inspection and annual certification; where the state has primacy, however, EPA plays a back-up role to the state in enforcing the SDWA requirements;
- provides funding and technical assistance to states;
- assists states in developing groundwater protection strategies;
- carries out special studies on contaminant levels and methods of treatment.

At the federal level, the regulatory picture is far from clear since, for example, groundwater is regulated by 16 different federal laws and there are at least 14 federal agencies with a role in groundwater management. Other agencies responsible for managing water resources include the Army Corps of Engineers and the Soil Conservation Service. The Food and Drug Administration regulates some bottled water. The result is a management problem characterized by overlap, duplication of effort and conflicting goals.

The Role of EPA

by Michael Cook
Director of the Office of Drinking Water, U.S. EPA

One of the major tasks of the Environmental Protection Agency, working with the states, is to assure safe drinking water. Our success depends critically on public interest activities. In particular, four contaminants present immediate challenges that are best faced and solved with active participation by a well-informed public.

Nationally, radon and other radionuclides, lead, microbiological contaminants, and byproducts of disinfection are the four types of substances that pose the largest health risks to consumers of drinking water. The causes for the presence of these substances, the kinds of risks they pose and the appropriate methods for reducing their risks vary widely. This article discusses why EPA considers these contaminants to be our highest priority, puts EPA's role in controlling the risks posed by drinking water contamination in perspective and emphasizes the importance of public education in protecting water supplies.

Radon and radionuclides

Radon, uranium and radium are three radioactive elements often found in drinking water. These materials occur naturally in the ground and dissolve into water supplies, often at high levels, before the water enters the water suppliers' wells. For example, EPA estimates that water supplied by as many as 1,000 to 10,000 public water systems has excessive amounts of radon; 200,000 to 4 million people across the nation are exposed to radon at levels that we project would cause a 1-in-10,000 chance of cancer in a lifetime of exposure, a level that EPA generally considers unreasonably high. Because these radionuclides are frequently occurring potent carcinogens, EPA will regulate radon and other radionuclides and strengthen the standard for radium in water supplies by June 1989. Fortunately, water suppliers can remove all three of these materials from water before it arrives in the home.

Consumers need to learn whether any of these chemicals are found in their water. Where significant concentrations of radionuclides are found, consumers should begin immediately to work with their water suppliers to apply treatment that will effectively remove the contaminants.

Lead

We have known for many years that lead is a particularly dangerous material. Since the United States has reduced exposure to lead in paint and gasoline, drinking water has become one of the most important remaining sources of lead exposure.

Lead can cause brain damage in children. It harms the central nervous system and interferes with learning and with physical growth. In adult men, lead interferes with the cardiovascular system and is associated with heart attacks and strokes. In women of childbearing age, lead can cause fertility problems and it can have severe health effects on fetuses and newborns.

Unlike most other contaminants of drinking water, lead usually gets into the water after the water leaves the treatment plant. It can leach from lead service connections that link buildings with water mains and lead solder that joins copper pipes together. This problem becomes much worse when the water is corrosive.

EPA has proposed to reduce the health-based goal (MCLG) for lead in water from 50 ppb to 20 ppb, and a stricter enforceable standard (MCL) will be in place by mid-1988. But people should not wait to begin reducing their exposure to lead in water. EPA welcomes all efforts by water systems and citizens to attack the lead problem.

Water systems should install corrosion controls to reduce the likelihood and amount of lead that enters drinking water. This type of treatment is effective, inexpensive (as little as 50¢ per consumer per year) and can save water suppliers and homeowners money that they would otherwise have to spend on fixing and replacing pipes damaged by corrosive water. Over time, suppliers can also replace lead service connections and water mains. This involves establishing a long-term plan to solve the lead problem.

In addition, consumers can take several important steps now to dramatically reduce exposure to lead in drinking water. First, have your water tested for lead (see Chapter Six). In the meantime, never drink water that has been standing longer than a few hours in pipes containing lead or lead solder. Run the water until it gets as cold as it can before using it for drinking or cooking. (This water need not be wasted. It can be used for such activities as watering plants or washing dishes.) Never drink or cook with water from the hot water tap, as hot water is more corrosive than cold water and may contain higher levels of lead. This step is particularly important to remember when preparing formula for babies.

Under the 1986 amendments to the Safe Drinking Water Act, use of solder and flux with more than 0.2-percent lead or pipe with more than 8-percent lead in plumbing connected to public water supplies is banned. Builders of new housing and people who anticipate repairing existing plumbing should be certain to use only low-lead materials.

The widespread occurence and severe health risks posed by lead contamination of drinking water cause us to place it among the highest priorities at EPA. Education of the public and water suppliers, close cooperation among those who can help, and quick action by all involved will help reduce this important, toxic problem. (For more information on lead refer to *Lead in Drinking Water: Should You be Concerned?* EPA. February 1987.)

Microbiological Contaminants

Bacteria and viruses have long been recognized as serious contaminants of drinking water. Organisms such as viruses (hepatitis A) or Giardia cause almost immediate gastrointestinal illness when people consume them in water. Even though much recent attention has focused on the dangers of chemical contaminants of drinking water, outbreaks of disease that could easily be prevented happen much too frequently. For example, over the last ten years, more than 20,000 cases of giardiasis from drinking water were reported nationwide.

Filtration and disinfection of water should effectively control the threat posed by these contaminants. EPA will publish final rules for filtration by December 1987 and for disinfection by June 1991. We foresee that the biggest challenge to the success of these programs will be to assure that even the smallest water systems obey the new requirements. We hope that local support for the program allows water suppliers to upgrade their facilities and assure the distribution of high quality water.

Disinfection Byproducts

One complication that arises in the control of microbiological contaminants is the formation of byproducts during the disinfection process. This class of chemicals, trihalomethanes (the product of chlorine combining with organic matter), can cause cancer in people. Therefore, when we establish the new disinfection rules, we will look for treatment methods that minimize or do not generate these harmful byproducts. We will strengthen the standards that control the amount of trihalomethanes allowed in drinking water and will consider whether additional standards of this type are necessary for other substances in order to protect public health. Public water supplies need to recognize these tradeoffs and choose disinfection methods that will minimize both the risk from microbiological contaminants and the risk from disinfection byproducts.

Other Contaminants

Certain organic chemicals, especially pesticides and volatile organic chemicals, also are of concern to EPA. These compounds form a second tier of concern because they pose serious health risks to consumers if they are present at high enough levels. Fortunately, these chemicals occur at high levels in very few water systems. As directed by Congress, we will regulate 83 contaminants by 1989, and we will list at least 25 additional contaminants for potential regulation by 1990. EPA recently issued final drinking water standards for eight volatile organic chemicals (see Figure 2).

As big as EPA's job is, the task facing water suppliers is even greater. Monitoring for potential contaminants of drinking water and treating water to meet the new standards will require major investments by water suppliers. The costs of the enhanced program will be passed on to consumers, who need to understand that the necessary price for continued assurance of good drinking water is higher water bills.

The Role of EPA and the Public

EPA is working to quickly set new standards for drinking water, to evaluate the effectiveness of water treatment alternatives and to assure that states implement the rules well. With only a few exceptions, the states are directly responsible for assuring that more than 60,000 water systems provide good, clean water.

In light of the enormous task of providing adequate oversight of the program, the role of the public is crucial to assuring high drinking water quality. There are three things the public can do: First, people should become familiar with drinking water standards and determine if the water they drink meets these limits. By understanding the standards and the requirements for monitoring and treatment, citizens will know which contaminants of drinking water are most important locally. Second, citizens should work with water suppliers to encourage and financially support adequate drinking water treatment. Close cooperation will help assure that suppliers will be able to deliver clean drinking water and that consumers will be satisfied with the quality of their water. And third, testing for lead, flushing water that has remained stagnant for several hours, installing corrosion controls and using only lead-free plumbing materials will help prevent the many risks posed by lead in drinking water.

The State Role

The primary role of states in the nation's safe drinking water program is enforcement. The 1974 Safe Drinking Water Act directs states to establish drinking water programs equivalent to that designed by the EPA. This ensures a basic level of drinking water protection state to state. States are said to have acquired "primacy" once their enforcement programs have been approved by EPA. These programs must have standards at least as strict as those set by EPA and must be able to adequately monitor and report water quality, inspect treatment and delivery systems, and respond to emergencies. States typically have 18 months after a regulation is promulgated by EPA to adopt and enforce the change.

While the federal program provides a certain level of consistency, states with primacy are free to set drinking water standards and regulations that are more stringent or comprehensive than those mandated by EPA. State regulations also can either encourage new water treatment technologies or create an environment with barriers to experimentation.

Currently, Indiana, Wyoming and the District of Columbia do not have primacy; drinking water in these states and DC is overseen by EPA's regional offices.

Another substantial role played by states in implementing the SDWA is that of liaison, transfering technical and financial assistance from EPA to local utilities, thereby ensuring that regulations are enforced and local utility operators

Safe Drinking Water in Washington State

by James C. Pluntze
Former Director of the Washington State Public Water Supply Program

The state of Washington has operated a statewide program to assure the adequacy and safety of public water systems for more than 50 years. The program has been conducted with the active participation of water utilities, citizens, local health departments, the state health agency, and since 1974, the U.S. Environmental Protection Agency.

The Washington Drinking Water Program

The Washington drinking water program is founded on the assumption that three key elements are necessary in order to achieve safe drinking water. First, there must be adequate physical facilities to treat, store and convey water to consumers. Second, these facilities must be operated and maintained by trained, capable personnel. Third, there must be a system of monitoring and surveillance to guarantee the effectiveness of the first two elements. Placing undue emphasis on monitoring/surveillance for contaminants without first assuring adequate facilities and operation is a prescription for failure. The Safe Drinking Water Act of 1974 has been criticized for skewing these priorities without addressing the fundamental issue of maintaining the infrastructure and operation. The SDWA left it up to EPA to ensure that water systems maintain their facilities and not focus solely on monitoring and enforcement.

Funding Assistance and Planning

Two tools have been used in Washington to achieve adequate public water system facilities. The first is the public water system funding program that was begun in 1973. When this program ends in 1988, it will have provided $130 million in state money to assist local governments with 40-percent matching funds for construction of water treatment plants, distribution reservoirs and reservoir covers, new source development, system interties, and water main extensions to serve areas with contaminated sources. A total of 700 projects have been constructed in the state, including every county. This program will continue with low-interest loans through an infrastructure bank.

To complement this funding program, the Public Water System Coordination Act was enacted in 1977. This legislation provides a mechanism whereby the state, acting as a convener and moderator, can bring local government entities together to plan for rational, contiguous service areas, system interties and common design standards or simply to work together on common issues such as basin-wide groundwater management.

In rural or suburban areas, the "satellite system program" has been used. A central entity, usually the county or a county-wide utility district, agrees to take the lead in assisting smaller scattered systems. Such assistance can take the form of planning, management, contract operation or total acquisition.

receive training and certification.

Increasingly, EPA's emphasis in managing drinking water and in protecting ground and surface water sources has been to allow states the flexibility to develop their own programs in response to their specific needs. Unfortunately, because neither EPA nor the states have committed the financial or technical resources necessary to do the entire job, the question arises as to who should pay for developing new programs while maintaining those already in existence.

Since many states may share or delegate drinking water supply responsibilities to local governments, there is often a blurring of local and state roles. Key functions of state health or environmental departments are to:

- establish drinking water standards that are at least as strict as the federal standards and that cover quality, surveillance, source development and facility construction (this applies to all states that have adopted "primacy," or primary enforcement authority under the SDWA);
- develop construction codes for well-drilling and plumbing systems;
- develop certification requirements for operating, laboratory, well-drilling and plumbing personnel;
- provide training for utility operators;
- provide state inspection of local utilities;
- act as the primary agency responsible for developing groundwater monitoring programs.

Operation

The best water system facilities will fail (and have) without capable operation and management. Certainly the level of operator competence in Washington today is far above that of yesteryear, but that is not necessarily good enough in today's era of computers, microcontaminant measurement capabilities and continually stretched budgets.

Washington has addressed this issue with mandatory certification of water system operators (since 1977) and a center for coordinating and tracking water and wastewater operator training. This has helped assure that water systems with more than 100 service connections have certified operators who have passed an examination and who receive on-the-job training. It is not a perfect system by any means, but it has greatly improved operator training in Washington.

Monitoring and Surveillance

Water quality monitoring and surveillance of water system operation always have been an important part of Washington's program, but this aspect of safe drinking water received new emphasis with the passage of the 1974 Safe Drinking Water Act.

The 1986 amendments to the act will further stimulate monitoring and correction of chemical contamination problems found. I hope that this will not result in less attention to the basic issues of proper source development and treatment.

A Time of Testing

The state of Washington has done a creditable job of achieving its goal of assuring safe and adequate drinking water for consumers. We have succeeded in this pursuit because we have built proper water system facilities and proceeded to operate and maintain those facilities. Surveillance and water quality monitoring verify that the first two elements are in place and doing their job. The 1986 Safe Drinking Water Act Amendments will ensure that a lot more monitoring is done for trace organic chemicals. This is proper and may be overdue, since some new contamination problems have come to light and more will follow. How serious these problems are in terms of health effects is still being debated, but no one is proposing to let them go unresolved.

The danger is that this new effort, starting at a time when federal and state budgets are stretched to the breaking point, will come at the cost of relaxed attention to the more mundane matter of drinking water protection. Many of these are very routine, such as changing chlorine cylinders; they must go on day after day, like breathing. If they are not maintained, all the progress made with the 1986 amendments to the SDWA will be counterproductive. This will truly be a test of state drinking water program managers, EPA overseers, and federal and state budget writers.

The Local Role

It is the responsibility of local government, municipal or county, to make sure that all water utilities meet strict health requirements and satisfy all state and local regulations.

In addition, at the local level rests the authority to:

- develop land use planning guidelines, such as zoning or wellhead protection programs;
- monitor pollution of surface and groundwater;
- develop treatment facilities and distribution systems;
- monitor and test drinking water and maintain records;
- run the treatment plant.

The Local Treatment Plant: A Matter of Size

by Ward Welsh
Vice-President of Community Relations
American Water Works Service Company

Mid- to large-sized treatment plants—those that serve populations of 25,000 or more—treat water pretty much the same way small plants do, but on a grander scale. They require bigger sources—larger streams or more wells, and more area for treatment basins and filters. Larger quantities of treatment chemicals call for easier truck or rail access. They need more and bigger pumps, larger mains—sometimes six feet in diameter—and more and larger storage tanks.

However, large suppliers usually can build and operate plants more efficiently than small suppliers because of the cost advantages associated with plant size and processing volume. The larger water systems also have the wherewithal to maintain larger and more specialized staffs. Most are staffed by certified technicians and chemists.

Within these parameters, water service and quality can vary significantly depending on a number of factors.

The Quality of the Water Source

The most critical determiner of the quality of drinking water is the quality of the source from which it is drawn. No matter how small a system is, if it is drawing from pristine streams or aquifers, consumers are almost guaranteed safe water.

But consumers should be cautious in evaluating sources because they are not always what they seem to be. Frequently today, sources assumed to be pure are found to contain invisible and tasteless compounds that might have entered the stream from an industrial dump, farm runoff, mining or drilling operations or even wild animal habitats miles upstream.

Protecting drinking water sources requires effective education of the public about the location and vulnerability of watersheds, strict enforcement of environmental regulations and constant—preferably daily—monitoring at the treatment plant intake.

Usually large purveyors are better able to patrol the watershed and monitor quality than the small suppliers.

The Age of the Plant

The root of many water quality problems in larger systems lies in the age of the treatment plant and the network of mains that delivers water to the consumer. Water plants and pipes are long-lived capital assets. They will "work" for 100 years. But as they age, they are subject to corrosion and disintegration—sometimes unseen—that can reduce water quality.

Old concrete deteriorates and cracks; old iron rusts. And both are subject to breakage and leakage. Old pumps fail more frequently and cause loss of pressure—pressure that's a fundamental defense against the invasion of impurities through cracks in pipe walls or joints. Large suppliers usually have greater staff resources and more revenue to maintain or replace antiquated plants. All things considered, newer systems should be safer systems. But, as with other mechanical systems, maintenance is almost as important as age in determining reliability and efficiency.

The Political and Economic Environment

As with most other things in life, politics and economics play a role in the quality of drinking water. A universal problem in the United States today, in large cities and small towns alike, is the gradual deterioration of the foundations of our communities, the so-called infrastructure: water systems, sewer systems, roads and bridges.

Many of these systems were built 50, 75 or even 100 years ago as our society changed from a mostly rural one to an urban one. They were built in an era in which labor was abundant and cheap, interest rates were low and growing populations could be counted on to share long-term financing costs. Many systems were built in the 1930s when the federal government undertook local public works to provide jobs and stimulate the economy.

Replacing these wornout systems in today's economic and political environment is a difficult challenge. Construction and financing costs have soared. Federal aid for such projects is limited—and thousands of communities are vying for it. The populations of most communities are stable or even shrinking. So the cost of replacing infrastructure—particularly water or sewer plants—can be significant—doubling water or sewer costs in some communities.

If your water doesn't seem *that* bad—"Our whole family grew up on it, and we're all healthy"—and you're not even aware of the conditions of your water plant, you are going to be hard-put to provide another couple hundred dollars a year in taxes or service rates for the next 20 years to upgrade it. Many elected officials will not push for improvements. The regulators who set the rates for private suppliers aren't anxious to approve rate increases, either. They were elected—or appointed—on the premise that they would hold rates down.

In our society, the suppliers of such services are not always the most credible advocates of plant expansion or improvement. In the view of the skeptical layperson, the city water department always wants to build; growth provides more jobs, better pay, more responsibility, more security. By the same token, investor-owned water suppliers are also seen as profiting by building. After all, their rates and income are based on the value of their investment, aren't they? So every dollar they invest generates new earnings for their stockholders.

Of course, the suppliers of these public services insist that they have a responsibility to provide, through carefully planned renovation and improvement, safe, environmentally sound services, not only this year but ten or 20 years down the road. They are committed to meeting that responsibility. But they need public support to get approval for major capital improvements.

Perhaps the most important groups in this connection are the government agencies: the Environmental Protection Agency, and the state and local health departments. As often as not, their counsel, prodding—even the threat of litigation—are instrumental in getting local communities to accept the rates required to improve water treatment and delivery facilities.

The Clean Water Act of 1972, which provided billions of dollars for communities to upgrade their sewage treatment plants, did more than any other federal law to clean up America's streams. And additional federal funds were just recently allocated for wastewater treatment projects.

But there's a Catch 22 in government subsidies.

For one thing, the possibility that the government might pick up the tab deters communities from acting on their own to solve local problems. What local public official will fight for a water plant that's going to cost constituent families another $200 a year for 20 years, if the official has heard that the federal government paid 75 percent of the cost of the new plant in the next town?

Many communities have gone through the long and expensive process of applying for federal aid, then planning and designing facilities to meet federal standards only to find that, by the time they were ready to build, the federal funding had dried up.

Thus, the wisest course for local organizations—public or private—is to determine what action is needed to keep vital publics informed of water service needs and to endorse improvements and mobilize public opinion behind those improvements. If federal funds are available, so much the better. But if they are not, the plans should go forward anyway.

5 Issues at the Heart of Water Quality

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The 1974 Safe Drinking Water Act and the 1986 SDWA Amendments are the culmination of a long and continuing effort to protect public health. Yet instead of calming the debate, the amendments have raised a host of unresolved and new issues. This chapter presents a variety of viewpoints on a number of issues that will affect the quality of drinking water locally and that also are the subject of state and national debate. The views—many of them conflicting—expressed in this section are presented to illustrate the multifaceted debate and are not necessarily endorsed by the League of Women Voters Education Fund. These discussions, most of them representing specific interests, serve as a good starting point for citizens seeking to understand the drinking water debate.

For example, in calling for the regulation of 83 new contaminants, the amendments have intensified the debate over the *way* in which standards are set, *which* contaminants should be regulated and *what level* provides an adequate margin of safety, over and *how long* EPA should have to establish the standards. The controversial question, "How safe is safe enough?" is discussed in this chapter.

Still other questions arise in defining responsibility and in paying for improved water treatment. What level of government should have primary responsibility for managing drinking water and groundwater? Who should bear responsibility for reducing lead levels in drinking water when lead enters the water through lead service lines and home plumbing systems after the water leaves the treatment plant? Should the service lines and plumbing pipes be replaced, and if so, by the utility, state or local government, the homeowner? How much will it cost and who should pay?

As the regulations under the new amendments are phased in, a major and longstanding controversy has reemerged over whether the level of treatment required for removal of contaminants should be based on current health effects data or on the lowest possible levels that can be achieved through technology. In other words, should standards for permissible levels of particular contaminants be based on what we know now about what levels are dangerous or on the lowest possible levels that can be reached through treatment technology?

The unique problems of small systems and rural residents also are explored in this chapter. Small systems are faced with tough choices in protecting sources without the broad revenue base on which large systems can rely to upgrade treatment.

One last problem discussed is the issue of protecting groundwater resources from contamination. Although groundwater is the source of 50 percent of the country's drinking water, neither the 1974 SDWA nor the 1986 SDWA Amendments effectively address groundwater contamination from improper waste disposal and industrial practices. Since a comprehensive and mandatory federal protection program does not exist, most protection efforts have depended and will continue to depend almost entirely on state and local efforts, or on provisions in 16 different federal statutes.

Drinking Water Standards —How Safe Is Safe Enough?

"One of the most distressing aspects of the job of administrator of EPA has been the recurring need to make regulatory decisions which cannot be deferred on a scientific basis, which can charitably be described as barely adequate. Time and again we must extrapolate from fragmentary scientific data and it seems that the frequency with which this must be done continues to increase."
Russell Train—former administrator of EPA

Just how much protection do the drinking water standards provide? This is a question without a single answer because safety is a relative judgment. There has been a continuing debate over how standards should be set and how stringent they should be. These questions are critically important in the management of drinking water because the level at which standards are set determines the potential health risks and the level of public confidence in the safety of drinking water. The standards in turn determine the level of treatment, which ultimatley determines the costs for providing safe drinking water.

U.S. drinking water standards have continually been revised since 1914 in response to changing needs and new information. For example, when the first federal water standards were written, viruses were poorly understood. Even today, there are great gaps in health specialists' knowledge about viruses—which ones can survive in drinking water, how they can economically and routinely be detected and identified, and how standard water supply treatment affects them. Similarly, the long-term effects of many chemicals and radioactive materials in drinking water are not fully understood. Federal drinking water standards are set at levels that—according to present knowledge—should produce no known immediate effects and only minimum effects after long-term (lifetime) exposure.

In setting standards, toxicity studies are conducted to identify the nature of health damage produced by a substance and the range of doses over which damage is produced. Information on the toxic properties of chemical substances is obtained from animal studies, controlled epidemiological investigations of exposed human populations and clinical studies or case reports of exposed humans.

Animal studies are the major source of health effects information for most chemicals. Government agencies and national science and health institutes generally accept the view that these tests can be used to judge a chemical's potential human toxicity. Yet, many issues are still unresolved.

The issue of dose levels is a particularly important one. Tests on animals often involve high doses of a substance, much higher than those to which humans would likely be exposed. Once a cancer or other physiological effect is produced in animals, the risk to humans must be calculated from the maximum exposure level in experimental animals that produces no observed adverse effects. Computer models that stimulate the human body's responses are used to extrapolate the animal data to humans and determine a safe human dose, known as the *threshold dose*.

There is always a degree of uncertainty in calculating the threshold dose and, depending upon the available health effects information, the degree of uncertainty can be quite large. To err on the conservative side, public health officials apply a margin of safety to compensate for the degree of uncertainty in determining the threshold dose. The greater the uncertainty in the assessment of risk, the greater the margin of safety.

Of course, each person has a different level of vulnerability, depending on such factors as age, diet, state of health and genetic makeup. The question of how to set "safe" standards, then, becomes an ethical dilemma, one for which science has no solution. Although there may be biological justification for safety factors to protect the most sensitive members of the human population, there is very little scientific support for the specific safety factors used. They are chosen to compensate for uncertainty. How safe is safe enough becomes more of a social question than a scientific one.

Setting Standards— A Viewpoint from the Water Industry

by Duane Georgeson
President of the Association of Metropolitan Water Agencies

It is in the interest of both the public and the water supply industry that EPA move aggressively to establish *simultaneously* all of the important new standards for public drinking water systems. Having simultaneous standards is of obvious importance to all water utility customers, because the cost of constructing and modifying treatment facilities is paid exclusively by the customer with no federal financial assistance and usually with no significant state assistance. For a local water utility to be able to design and build costly new water treatment facilities or modify existing ones, the utility must have available promptly *all* of the important new standards, not just some of the standards.

Unless comprehensive standards are established promptly, customers' funds could be invested in new treatment plants that quickly will become obsolete as later standards unfold from an ill-conceived, piecemeal and fragmented standard-setting process.

The distinction between risk and safety is essential to understanding environmental standard-setting. *Risk* is the probability that something undesirable will happen. Risk measurement draws upon scientific understanding of the relationship between exposure and effect and, although it cannot predict specific events, makes statistical projections about the frequency with which an event will occur in nature.

Safety, on the other hand, is a policy question that involves weighing identified risks and benefits. The word "safe" has different meanings for different people. Most of us believe in the dictionary definition that safe means "freed from risk or harm." But in reality, absolute safety does not exist.

One constant is that human activity will always and unavoidably involve risks. Therefore, some degree of risk must be considered acceptable to society. However, risk and degrees of risk, as well as safety and degrees of safety, evolve according to individual perceptions and personal and social standards of acceptability.

In setting drinking water standards, EPA has taken the position that there should be zero level of carcinogens in drinking water, but that given the realities of the day, this zero level can only be used as a goal for which to strive. For this reason, EPA sets maximum contaminant level goals (MCLGs) for contaminants at zero. MCLs, or enforceable standards, are then set as low as possible taking economic considerations into account. Critics believe that this approach ignores scientific health effects research and that safe, acceptable levels of exposure to carcinogenic substances can be determined. They argue that by setting a zero level goal, EPA establishes an unrealistic and unnecessarily strict final standard.

In an effort to present two sides of the issue, the LWVEF asked Dr. Robert Neal, President of the Chemical Industry Institute of Toxicology, and Jeanne Briskin, Special Assistant to the Director of EPA's Office of Drinking Water, to present their perspectives on the issue.

Carcinogens in Drinking Water: Is Zero Contamination a Goal We Can Meet?

Point

by Robert A. Neal
President of the Chemical Industry Institute of Toxicology

In 1985, the U.S. EPA published its long-awaited recommended Maximum Contaminant Level Goals (MCLGs) for eight volatile organic chemicals (VOCs) occurring as drinking water contaminants. As required by the Safe Drinking Water Act, EPA simultaneously proposed the enforceable MCLs for the eight volatile organic chemicals. The MCLs, or primary standards, are to be set as close to the MCLGs (the health based goals) as feasible "with the use of the best technology, treatment techniques and other means, which the Administrator finds generally available (taking costs into consideration)."

EPA recommended that MCLGs for carcinogenic organic contaminants be set at zero even though the Safe Drinking Water Act (SDWA) does not specifically require that the MCLGs for carcinogens be set at zero. Rather, the law states that the MCLGs are to be set at a level at which, in the EPA administrator's judgment, "no known or anticipated adverse effects on the health of persons occur and which allows an adequate margin of safety." However, EPA feels that an MCLG of zero for carcinogenic chemicals is justified on the basis of the "legislative history of the SDWA."

In setting the MCLs for organic carcinogens as close to the MCLGs of zero "as feasible," the EPA has chosen to use the practical lower limit of the ability to analytically detect the chemical as the MCL. Using this approach, EPA has in effect chosen to disregard human (epidemiological) data, cancer dose-response information from experimental animal studies and other relevant health effects data in setting the MCL. In effect, the EPA Office of Drinking Water has, in the case of organic carcinogenic chemicals, taken the position that any amount of an organic carcinogen in drinking water, even a single molecule, poses an unacceptable risk to human health. This reasoning is inconsistent with that of other offices within EPA and other regulatory agencies, with the exception of certain regulatory actions of the Food and Drug Administration (FDA).

The question central to this issue is: "Is there a safe level of exposure to a carcinogen?" Other offices within EPA have concluded that there are acceptable levels of exposure in air to some of the organic carcinogens for which the Office of Drinking Water has concluded there is not an acceptable level in drinking water. The federal Occupational Safety and Health Administration (OSHA) also has concluded there are acceptable levels of exposure to some of these chemicals.

The Delaney Amendment to the Food, Drug and Cosmetic Act states that no amount of a carcinogenic chemical can be ***deliberately added*** to food. This is the

only other example of a regulatory agency ruling that there is no safe level of exposure to a carcinogen. However, the FDA does allow the presence of some level of carcinogenic chemicals in food *if they have not been deliberately added to the food.*

In each case the level of the chemical allowed in food is determined using data from humans exposed to these compounds, dose-response effects in experimental animals and other available data on the health effects of these chemicals. Because the chemical carcinogens present in drinking water also occur inadvertently, the Delaney Amendment does not provide a precedent for EPA's setting the MCLs for these organic carcinogens in drinking water at the lowest detectable level.

The reasoning used by EPA in setting the MCLGs for inorganic carcinogenic contaminants in drinking water is quite different from that used for organic carcinogens. Thus, MCLGs greater than zero are recommended for the inorganics, most of which are known human carcinogens. No adequate rationale is given by EPA for treating inorganic carcinogens differently from organic carcinogens. Additionally, in setting the MCLGs for inorganic carcinogens, EPA has again largely ignored human and experimental animal data about the carcinogenic effects of these inorganic compounds and the relevance of these data to assessing human risk resulting from exposure to these compounds.

The point is that MCLs for both organic and inorganic contaminants in drinking water should be based on a careful consideration of all of the relevant health effects data as well as on practical issues such as feasibility. By setting MCLGs at zero, the MCLs will be based on technology—the analytical limit we can detect, disregarding health effects information. Consequently, limited resources may be spent controlling chemicals to levels that pose no significant health risk, monies that may be better spent on improving the overall quality of the nation's drinking water supplies.

Setting the MCLGs for organic carcinogens at zero will, in the end, have an adverse effect on the regulation of carcinogenic chemicals in drinking water. This approach ignores differences in carcinogenic potency of chemicals, abandons the use of "weight-of-evidence" in assessing potential human cancer risks, and disclaims the cancer risk assessment procedures used by other regulatory agencies and other programs within EPA. The result may be to discourage scientific investigation of drinking water contaminants. Why test a chemical contaminant for its potential carcinogenicity if carcinogenic potency or other data pertaining to its potential to cause cancer in humans is ignored? In addition, why attempt to develop sensitive practical analytical methods for carcinogenic chemicals in drinking water if the more sensitive analytical method rather than an evaluation of the available health effect data will decide what the MCL will be?

Counterpoint

by Jeanne Briskin
Special Assistant to the Director of EPA's Office of Drinking Water

Under the Safe Drinking Water Act, EPA is required to set limits on the allowable amounts of contaminants in drinking water. Congress mandated that the agency take two steps. First a nonenforceable health-based goal (maximum contaminant level goal or MCLG) is developed. This goal must be set at a level where no one will experience adverse health effects, with a margin of safety. For most chemicals this requirement poses little problem to us. However, setting MCLGs for carcinogens is more troublesome.

The agency's risk assessment guidelines clearly state that in evaluating the effects of exposures to carcinogens, we should rely on the evidence indicating that even exposure to very low levels of a carcinogen may increase a person's chances of getting cancer. Therefore, for carcinogens, EPA sets MCLGs at zero to meet the statutory requirements.

Chemicals with equivocal evidence of carcinogenity are borderline cases. Rather than setting the MCLG at zero, we develop the goal based on other systemic health effects and then include an extra safety factor. This extra margin of safety assures that, if the chemical does turn out to be a carcinogen, then the standard will still protect human health.

The second step is to set MCLs, the enforceable standards which water suppliers must meet at the consumer's tap. Congress directed that these standards be set as close to the health-based goals as is feasible, taking cost into account. The factors that support the regulatory options include: contaminant occurrence, the performance of treatment techniques, cost of treatment, practical quantification limits (the lower limit of the ability to routinely analytically detect the chemical in a well-operated lab), and the residual risk after regulation. Note that this process results in a nonzero number that is determined to be an acceptable risk. For all chemicals, including those with MCLGs of zero, all available relevant dose-response, carcinogenic potency and epidemiologic evidence is at hand. Thus, decision makers are informed of the health and practical implications of each regulatory option.

The statutory mandate to set MCLs as close to the health-based goals as possible is one reason why drinking water standards for substances with goals of zero will be very low. But other approaches toward standard-setting might well lead to the same result. Consider that, commonly, the concentrations of carcinogens in drinking water that correspond to a one-in-100,000 to one-in-one-million individual lifetime risk tend to be very low, many times in the low part-per-billion range. This same range often represents the

limit of practical quantification. Therefore, even if MCLGs were set at low nonzero limits, the MCLs would be the same or very similar to ones developed under the present system.

The outlook for future research is bright. Research on all potential health effects of drinking water contaminants are used not only to set standards under the Safe Drinking Water Act, but also to set other health and environmental policies and rules. Improvements in the performance of detection and measurement devices will rarely, if ever, drive drinking water standards to exotic new lows. Treatment performance, contaminant occurrence, magnitude of risks and other factors have and will continue to play an important role in standard-setting.

In summary, the goals and limits for contaminants in drinking water are set using all available information. We do not have a zero-risk approach. As we implement the Safe Drinking Water Act by using a risk management approach within the legislative constraints, we develop reasonable, well-supported, but conservative standards. When the numbers come out low, they do so because the data show that protection of human health requires it and we are confident that water suppliers are able to provide water of this high purity.

Shortcomings in EPA's Drinking Water Standard Setting

by Jacqueline Warren
Senior Attorney for the Natural Resources Defense Council

When Congress passed strengthening amendments to the Safe Drinking Water Act in June 1986, the slow pace of standard setting was one of the problems that received attention. Citing the fact that EPA had set only 23 standards in 12 years, Senator Durenberger of Minnesota characterized the agency's record as "miserable, discouraging, disturbing . . ."

Not only have the standards been few in number, but they are not adequately protective of human health in many instances. Although the list of MCLs is now longer than ever before, as a result of the recent issuance of standards for volatile organic chemicals, the adequacy of the standards to protect public health remains seriously in question. Many of the initial standards were enacted as a simple codification of the 1962 Public Health Service Standards and were intended by the 1974 law to provide "interim" protection until more comprehensive standards could be established. The eight standards for volatile organics published in July 1987 comprise the first list of such "comprehensive" standards—but they have many deficiencies.

For example, the standards for carcinogens allow high risks for cancer, i.e., risks greater than one-in-10,000. Although EPA has described cancer risks in the range of one-in-10,000 to one-in-one-million additional cases of cancer as "normal" and "reasonable," such risks could result in large numbers of additional cancer cases in the U.S. population, if everyone were exposed at the levels set by EPA. To illustrate the problem, a one-in-10,000 risk would allow 24,000 additional cancer cases in the entire population. A one-in-100,000 risk would allow 2,400 additional cancer cases, and a one-in-one-million risk would allow 240 additional cancer cases. Since these risk numbers apply to each contaminant separately, the risks would be additive for each contaminant present in an individual's drinking water supply. Under a statute that directs EPA to protect consumers against both known and anticipated risks, these standards fall far short of protecting public health.

The list of drinking water standards, both existing and proposed, has many other deficiencies. Many are above the levels at which New York State, for example, will close a well. Others exceed odor and taste thresholds, and still others have been set with inadequate attention to the special sensitivities of children, the availability of data on possible carcinogenicity, and the fact that exposures occur from multiple exposure routes, such as inhalation and diet.

The setting of standards under the Safe Drinking Water Act is now of central importance for more than just water suppliers. EPA's standards are being used for corrective action at operating hazardous waste facilities, for clean-ups at Superfund sites and as guidelines for allowable levels of pesticides in drinking water. EPA may believe that cancer risks at and above one-in-10,000 represent a "sufficient level of protectiveness," but many disagree. The public is demanding and deserves the greatest degree of protection against harm that drinking water sources will allow. EPA's drinking water standards do not provide that level of protection, but they should.

How Much Will It Cost?

In calling for the increased regulation of drinking water, the 1986 amendments will place added burdens on community water systems. Since there are no provisions for additional federal funding for water utilities, many system operators, states and local communities are wondering how they will pay for increased monitoring and expansion of treatment facilities. The additional costs ultimately will be passed on to consumers through tax increases or higher water bills.

Just how much will it cost? While estimates vary depending on the source, EPA, which ultimately must defend any decision to regulate specific treatment techniques to the water industry, has estimated costs for a few of the various forms of treatment. (See Figure 7).

Figure 7 **Costs of Some Water Treatment Technologies**
Basic Assumptions:
- 3.2 persons per household
- each person using 180 gallons per day
- total cost per household including operation, maintenance and amortization of capital at 10 percent per year for 20 years

Population Range	Type of Treatment	Cost per Family per Year
501–1,000	conventional coagulation filtration and disinfection to control microbial contaminants	$125
50,001–75,000		$ 50
>1,000,000		$ 25
501–1,000	corrosion control (stabilization with lime) to control lead and other corrosion products	$ 60
50,001–75,000		$ 15
>1,000,000		<$ 10
501–1,000	packed tower aeration to control organic chemicals	$ 55
50,000–75,000		$ 28
>1,000,000		$ 20
501–1,000	granular activated carbon to control synthetic organic chemicals	$190
50,001–75,000		$130
>1,000,000		$ 40

Source: U.S. Environmental Protection Agency

Financial Issues Involved in Water Supply: A Utility Perspective

by James Barr
Senior Vice President of the American Water Works Service Company

There are basically two forms of utility ownership in the water business: public ownership and private ownership. Ownership in this context relates to the physical assets of facilities used to provide water service, not to the water itself. For this purpose, ownership relates to the control of pipes, pumps, filters, fire hydrants, land and other physical assets utilized by a utility to deliver water to the homes and businesses in a community.

Public ownership includes municipal or regional governmental entities that manage water utilities and whose facilities are owned by those who receive the service provided. Private ownership includes business enterprises established to service a community. The facilities used to provide service are owned by those who own the business.

The level of water service provided to a customer is not affected by the nature of utility ownership. However, the development and management of financial resources needed to provide water services is affected by the form of ownership. Water service is a capital-intensive business, primarily because of the following three factors:

- much of water systems must be constructed underground;
- water systems must be built to meet peak requirements of customers;
- water systems last a long time; therefore, replacement and renewal are accomplished at exaggerated costs due to the impact of inflation.

The ability to provide proper water service is wholly dependent upon the rates charged for water used. There are many philosophies about how to establish rates for water service, but whatever the rate is it must provide the revenue needed to cover the cost of the service provided. There is a tendency to complicate this basic principle by interjecting various social and political issues into the water rate-making process. The impact of these factors must be decided on a case-by-case basis, but in each instance it must be recognized that the more they influence rate decisions the more they compromise adequate funding of water service.

Water rates imposed by publicly owned entities are normally established by municipal ordinance or action of the local governing body of the entity involved. In some cases a state agency may have jurisdiction over the rate-setting process. In the case of privately owned suppliers, rates for service must be established by a state regulatory agency.

Rates for service in various communities cannot be meaningfully compared with one another. Likewise, a rate comparison based upon the form of ownership is meaningless. There are so many local issues and influential factors involved in rate making for water service that it is basically impossible to compare the rate in one area with the rate in another area. The more meaningful assessment in this regard is how the rate for service has changed over time in the same community, and whether it provides enough money to insure the adequacy of service in the future. This judgment must be viewed in the context of local issues and should not be diverted by factors unrelated to local service.

A water utility, regardless of ownership, must be financially viable in order to provide proper service. Virtually all water service deficiencies that the public experiences can be traced to financial limitations. The question to be resolved is whether or not the deficiency is such that it is unsatisfactory. If so, financial decisions must be made to correct it. Any assessment of financial viability of a water system should center around the following questions:

1. Is there sufficient revenue to insure the ability to attract and retain professionals in the field of water supply?
2. Is there sufficient revenue to purchase all of the materials and equipment necessary to provide proper water service every day?
3. Is there sufficient revenue to provide funding for proper maintenance of all water system facilities in a way that insures their availability for their entire useful life?
4. Is there sufficient revenue to provide the money required to replace worn out facilities at the end of their useful life?
5. Is there sufficient revenue to permit the water system to build new facilities when it becomes necessary to improve service or expand the water system?

If all these questions can be responded to in the affirmative, without qualification, the community is served by a financially viable entity. In the absence of an affirmative response to any one of these questions there is reason for concern about the adequacy of water service.

Regulating Organic Chemicals: Two Approaches

"We will never know precisely what the dose-response relationships are for the hundreds of chemicals found in drinking water. But we do know the removal efficiencies of best available treatment technology."
Senator David Durenberger (R MN), 1984

Ever since organic chemicals began showing up in drinking water, a debate has raged over the best and most practical approach for regulating them. In the late 1970s EPA proposed that a particular technology—granular activated carbon (GAC) treatment—be mandated as the most practical means for controlling synthetic organic chemicals (SOCs). Although in 1981 EPA withdrew its proposal to use a technology-based approach in controlling organics, the issue of how best to regulate organic chemicals in drinking water is again coming to the fore in response to EPA's mandate to regulate 53 new contaminants and the requirements that, for each standard established, EPA is to list the technology and treatment techniques most feasible for meeting the standard (MCL).

The debate centers around two competing philosophies. In a health-based approach, contaminants in drinking water are regulated by setting an MCL standard. If control of organic chemicals can be mandated on the basis of health effects data, then setting and attaining a standard that provides an adequate margin of safety should provide a sufficient level of public protection.

The other alternative, similar to that proposed by EPA in the 1970s for controlling synthetic organic chemicals, is to set MCLs for organic contaminants on the basis of the ***technical capabilities*** of the Best Available Technology (BAT). In a treatment-based approach such as this, EPA would ***mandate*** the specific appropriate types of treatment to be used in controlling specific contaminants. To date, EPA has proposed granular activated carbon (GAC) and packed tower aeration (PTA) as the Best Available Technology for the control of organic chemicals.

Although GAC has been around for years, only about 50 facilities use it in the treatment process, mainly for taste and odor control. The Cincinnati Water Works will soon be the first major utility in the United States to use GAC specifically for the control of organics. While the city of Cincinnati has determined that GAC treament is the answer to its water quality problems, this does not imply that it is the answer for every city. Although GAC is considered the Best Available Technology (BAT) for the removal of organics, each utility has different problems, and only by looking at the quality of the source water, the health effects data, cost estimates and the operating criteria can the appropriate decision be made regarding the most feasible method of treatment.

The Cincinnati experience, discussed on the following pages, is an example of how one utility is attempting to solve its water quality problems.

Cincinnati's Plans to Improve Water Quality

by Richard Miller
Director of the Cincinnati Water Works Department

Cincinnati's drinking water meets all of the standards currently prescribed in the Safe Drinking Water Act. Why, then, are we advocating the use of a new treatment plant that uses granular activated carbon in our city?

To understand our reasoning, you need to know something about our raw water source, the Ohio River. From the standpoint of contamination by synthetic organic chemicals, the Ohio is probably one of the nation's most polluted rivers. More than 150 million tons of freight are transported on the Ohio River annually. Approximately half of that amount is transported on the river upstream of Cincinnati.

Over 30 million tons of these commercial products are classified as hazardous materials, or materials that can severely impact water quality. Among these are phosphate chemical fertilizers, sulfuric acid, benzene, toluene, gasoline, jet fuel, kerosene, distillate fuel oil and nitrogenous chemical fertilizer. The list goes on, and many of the substances that are currently regulated by the Safe Drinking Water Act or are proposed for regulation are transported on the Ohio River.

Discharges and spills from the steel mills in the Pittsburgh, Pennsylvania area and from the chemical plants on the Kanawha River in the Charleston, West Virginia area are a fairly common occurrence. Pittsburgh is located 463 miles upstream of Cincinnati. In 1977, one chemical company discharged more than 70 tons of carbon tetrachloride into the river. This suspected human carcinogen found its way into many water intakes. Spills of benzene, which is classified as a known human carcinogen, also have occurred with disturbing frequency.

Cincinnati's existing water treatment plant does not have the capability for removing such contaminants.

Recognizing the potential concerns for the safety of its water quality, Cincinnati decided that research was needed to evaluate methods for reducing the threat of synthetic organic contamination.

In August 1977, the U.S. EPA awarded the Cincinnati Water Department a research grant to determine whether granular activated carbon (GAC) adsorption was a feasible method for removing trace organics from Ohio River water while treating it for human consumption. To be considered feasible, the facility had to remove these organics to a predesignated level at a cost acceptable to consumers and without impacting the treatment provided by the existing plant. A secondary objective was to develop design and operating parameters for full-scale plant conversion to GAC treatment.

During the pilot study, covering a period from August 1977 to May 1982, thousands of samples of both raw and finished water were collected and analyzed. The results of the sample analyses made it clear that trace amounts of synthetic organic chemicals were present on a continuous basis.

The list of trace organic contaminants that have been identified in the Ohio River, and in our treated water, continues to expand. We have collected monitoring data that identifies approximately 225 specific organic chemicals. Our monitoring data indicates that 106 substances are present on an average basis. EPA has reported more than 400 specific organics during a one-time survey. These study results show there is a wide variety of substances present in low concentrations.

The accompanying chart lists ten of the most frequently detected organic substances and their detection frequency, and provides some perspective regarding the concentrations of these substances. The number of detections show that there are more than just occasional occurrences of these compounds.

The data indicate that high concentrations are not generally detected but that some substances are ubiquitous at low concentrations. These data trends likely are representative of many U.S. industrial river sources such as the the Kanawha, the Ohio, the Delaware, the Mississippi and others. Unfortunately, most of the contaminants found in surface water sources are of the higher molecular weight variety and are not well removed from the treatment process without the use of GAC adsorption techniques.

The research project proved conclusively that granular activated carbon effectively removed almost all of the organic contaminants for extended periods of time. Over a four-month period, many compounds continued to be removed at a high efficiency regardless of influent concentration: 1,1,1-trichloroethane (87–100%); benzene (100%); 1,2-dichlorobenzene and tetrachloroethylene (98–100%); and carbon tetrachloride (93–100%). Toluene was poorly removed when the concentrations were very low; however, when the concentrations increased, it was effectively removed (99–100%).

The GAC systems evaluated at Cincinnati were not specifically installed for the removal of trihalomethanes (THMs). However, the research data indicate that a significant reduction in THMs did occur. Chloroform, the most prevalent THM, was removed between 72–100% over the four month period.

Approximately 750 tons of spent or exhausted carbon were reactivated on-site during the experimental work. The cost of on-site reactivation was approximately 21¢-per-pound as compared to 80¢-per-pound for new carbon. Fortified with the fact that GAC would effectively remove the organic contaminants and that it was practical and cost effective to reactivate the material on-site, a recommendation was made to Cincinnati's city council to construct a plant to treat all of the city's water, 175 to 220 million gallons per day. The council approved a water rate increase that would support the detailed engineering design. When the design

Top Ten Raw Water Contaminants Detected

Substance	Detection Frequency %	Concentration in mg/1	
		Maximum	Average
Chloroform	81	5.40	0.2
Benzene	60	4.50	0.2
Toluene	47	18.60	0.2
Dichloromethane	41	11.90	0.12
1,2–Dichlorobenzene	24	1.20	0.05
Tetrachloroethylene	14	0.44	0.03
1,1,1–Trichloroethane	12	1.00	0.03
Ethylbenzene	9	33.00	0.10
1,2–Dichloroethane	7	2.00	0.01
Trichloroethylene	7	0.20	0.01

was completed, a very comprehensive and detailed construction cost estimate was prepared.

Total construction cost of a GAC facility adequate to treat all of Cincinnati's water was estimated to be $50 million at 1986 costs. The annual cost of approximately $8.5 million would require $4.5 million for debt service and $4 million for operation and maintenance. This equates to 21¢-per-thousand-gallons. The cost per family will be 7¢-per-day, or $27-per-year, certainly a true bargain when compared to the cost of bottled water or home treatment devices. Cincinnati's city council passed a resolution supporting construction of the plant which should begin in 1987. The facility will provide Cincinnati with water of unquestionable quality, a product that our customers both desire and deserve.

The Special Problems of Small Systems

While there has been a concerted effort at upgrading community drinking water systems, there are still a number of obstacles to providing safe drinking water to people in rural areas who frequently rely on individual or small multiple-connection systems. Many rural water systems, due to their small size, fall outside the regulatory arm of the federal government.

An EPA national survey of rural household water conditions in 1978 found that bacterial contamination was the most prevalent water quality concern in rural systems. More than 40 percent of those served by individual or intermediate size systems (2–14 connections) had coliform concentrations exceeding the primary standard. By contrast, the comparable rate for households served by community systems (at least 15 year-round service connections) was 15 percent.

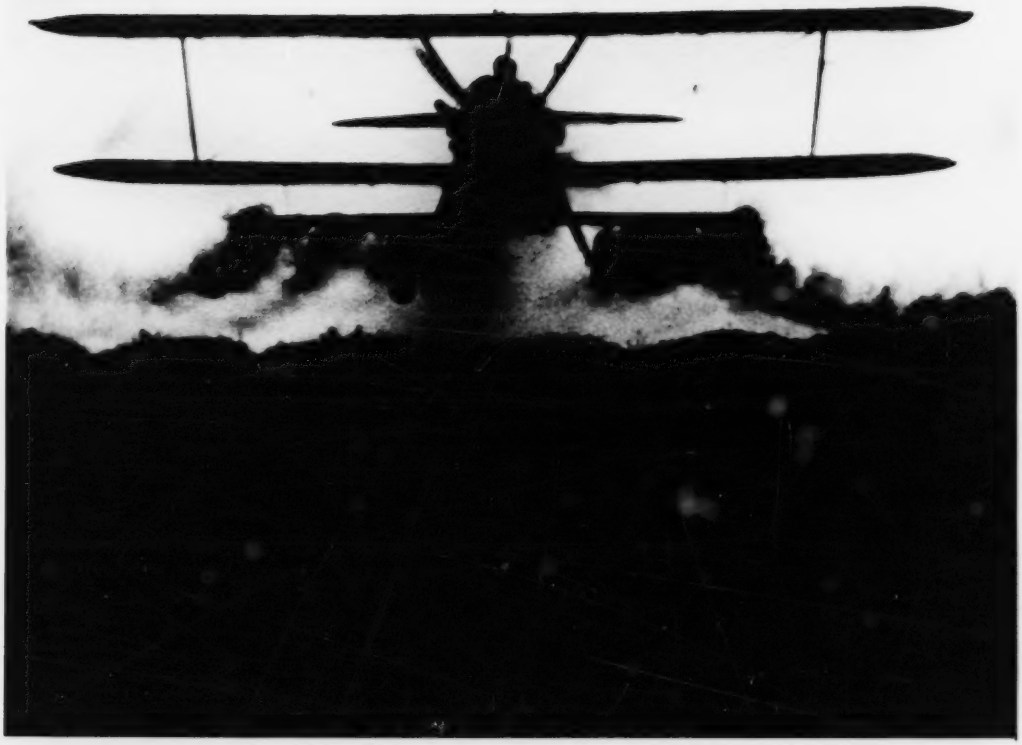
EPA concluded in its study that direct regulation of small (usually individual) water systems would probably not dramatically alter water quality. Small systems commonly lack treatment devices due to the relatively large capital costs of their purchase, installation, operation and maintenance for the individual involved. Instead, EPA recommended that the most feasible way to ensure safe drinking water for individual systems would be to protect the quality of groundwater sources of drinking water in the first place, ensure acceptable well construction practices are used for households using individual and intermediate wells, and to focus on more widely available water testing services and public education.

In the past, the problems of small private water systems have been viewed as the responsibility of the individual owner. Only in crisis situations has the problem of contaminated wells been addressed through construction, expansion or the merger of public water systems, or through the provision of bottled water or home treatment devices. See Chapter Six for more on these alternatives.

It is not feasible to finance public water systems that will serve every rural household that now relies on well water. Yet, as long as small water systems are a source of drinking water for

rural residents, and as long as problems persist in supplying rural residents with safe drinking water, there is a need for continued efforts to address the problem.

Currently it is the responsibility of rural residents to assure that they have safe drinking water. Citizens must become involved in resolving these problems with state and local governments. Some questions to raise and think about in this debate are: In an effort to help small community water systems, should the state be the supplier of grants or loans for upgrading local water systems? Should the state require the expansion or merger of public water systems to incorporate small systems facing difficulties in meeting the requirements of the SDWA? Whose responsibility should it be to ensure that rural residents with private wells are assured safe drinking water? The federal government? The state? The individual?



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Drinking Water and Rural America

by Sam Wade
Training Director for the National Rural Water Association

In the past, many officials governing small systems viewed the water system as an operation that required neither skill nor knowledge to operate.

However, as the knowledge of health effects of substances that can contaminate water increased and environmental concerns were forced into the spotlight, the nation's drinking water supply became a primary concern. The passage of the Safe Drinking Water Act in 1974 was the first major law underscoring the serious concerns of the federal government. These concerns soon filtered down to the local government, and as systems came into compliance with the act, local officials began to realize the complexity of even the smallest system.

The problems of the future are expanded problems of the past. In 1986, Congress passed amendments to the Safe Drinking Water Act that will ensure a safer supply of water. Compliance with these amendments also will require capital expenditures and more complex treatment processes. The amendments require additional testing for yet-to-be-named contaminants. Where these contaminants are found, small systems, serving populations of 5 to 2,500, will experience financial hardships and will require additional loans and grants. The alternative to a public supply, however small, is a return to individual wells and the consumption of water of an unknown quality. This reversal would be a step backward in the public water supply industry as well as the public health field.

Rural and small communities cannot have different standards than their big city cousins; however, they do need the avenues to borrow and repay loans at an affordable rate. One such program is the Farmer's Home Administration Community Facilities program. This program has financed the majority of water and wastewater systems throughout the country in systems under 10,000 population. This program also is the only avenue for rural water systems, which supply water to small towns and rural homesteads. Yet this pay-back program with a less than 1 percent delinquency rate has been targeted for elimination for the past four years. Legislative support from representatives of the large population centers will be needed to meet the needs of rural residents, if there is to be a true rural America in the future.

Protecting Groundwater

Groundwater supplies half of the country's drinking water. In rural areas, groundwater provides as much as 95 percent of domestic water supply, and 34 major U.S. cities, including Miami, San Antonio and Los Angeles, rely exclusively or in large part on groundwater for drinking water supplies.

Currently, no single federal law addresses the protection of groundwater in the way that, for example, the Safe Drinking Water Act seeks to protect drinking water quality. Rather, as the "invisible" resource, groundwater has been protected in a piecemeal fashion by adding provisions to other pollution control statutes as they are reauthorized. The resulting national groundwater "policy" consists of provisions in 16 statutes overseen by numerous federal agencies with little coordination of programs. State programs for groundwater protection, where they are established, reflect this federal fragmentation.

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Traditional pollution control laws, such as the Clean Water Act and the Clean Air Act, have sought to control pollution at its source—the discharge pipe or smokestack. Can groundwater be protected by using this traditional approach? The problem is difficult since protection of groundwater requires the wise regulation of all activities within a watershed, which in addition to the so-called "point" sources of pollution (landfills, septic tanks) includes the control of "nonpoint" source pollution, such as the runoff from city streets and farmers' fields with no direct "source" on which to place controls.

In 1984, in response to state and local governments' rapidly growing need for guidance on how best to protect groundwater, EPA established a National Groundwater Protection Strategy to integrate the numerous pollution control programs related to groundwater. This strategy formally gave states the lead role in setting and implementing groundwater policies. By providing some federal financial support and guidance, EPA encouraged the states that have not established groundwater management programs to do so. However, while some states have used EPA's assistance to establish groundwater protection programs, many have not.

The 1986 amendments to the Safe Drinking Water Act established two new programs for states to use in developing groundwater protection strategies: the Wellhead Protection Program and the Sole-Source Aquifer Demonstration Program. (See Chapter Three.) The lack of a federal directive on groundwater protection has resulted in various approaches to—and various degrees of—groundwater protection in the states. Many feel the lack of federal leadership allows states the flexibility to design programs tailored to their legislative/political systems, sources of groundwater pollution and characteristic hydrogeology. Others contend that a federal program is necessary to maintain consistency and enforcement from state to state.

Some states are not waiting for a congressional mandate to develop groundwater protection programs. In deciding what strategy to take to protect groundwater, states must consider whether they want to:

1. maintain all aquifers for use as drinking water supplies;
2. prevent any additional degradation of existing aquifer quality;
3. designate some aquifers for protection and allow others to degrade.

The three tools generally being used by states in some combination to protect groundwater are the classification of aquifers, the establishment of groundwater standards, and the issuance of permits to control pollution discharges to groundwater.

Classification of Aquifers. To date, more than ten states have classified their aquifers, the first step in a long-term use plan or water quality goal for aquifers. This classification depends primarily on an aquifer's existing quality, accessibility and vulnerability to contamination and the state's water needs. The classification of aquifers requires careful mapping of hydrogeological conditions, entailing a great investment of time and funds. Generally, the classification of an aquifer for a specific use or water quality goal implies the level of protection it will receive. The methods of protection might include water quality standards, land use controls or permits to restrict discharges to the land. The classification of an aquifer gives the state, county or town the legal backing to enact necessary protection measures.

More than a decade ago, New Mexico—where 90 percent of the state's drinking water supply originates as groundwater—created two classes of aquifers (potable and unpotable) based on the natural background levels of minerals. The state now combines this classification with strict "discharge plans" for any discharger (agriculture and oil industries are exempt, however), and corresponding groundwater quality standards. These restrictions serve as incentives to curb development where vulnerable hydrogeological conditions overlap an aquifer that is classified as potable. If any contamination does occur, even after the discharging facility has closed, the burden of proof lies with the discharger to prove it did not contaminate the aquifer.

Fewer restrictions exist in New Mexico for the discharger who develops in an area where the contamination of an *unpotable* aquifer is likely. This raises a controversial and philosophical issue in the classification of aquifers, the issue of

planned groundwater degradation. Should states allow, as some currently do, for some aquifers, based on their high natural background mineral content or previous contamination, to be designated for degradation, including direct waste disposal? New Hampshire and Maine have established "nondegradation" policies for *all* aquifers in their states.

Groundwater Quality Standards. Like the health-based drinking water standards established under the SDWA, some states have established groundwater quality standards. These standards can apply a blanket protection to all groundwater in the state or correspond to an aquifer classification scheme. Some states use EPA's drinking water standards as the groundwater quality standards.

Wisconsin has taken an innovative approach. The state has set two types of standards, a "preventive action limit" and a health based, enforceable standard (essentially an MCL). When the first is exceeded, actions are taken immediately to try to prevent that contamination from reaching the health-based standard, which could result in a closed water supply.

Wisconsin's approach raises new questions which policy makers are currently grappling with: Does the setting of groundwater standards convey that there is an acceptable level of pollution? What level of clean-up should an aquifer or well receive if it becomes contaminated: to the nonenforceable goals (MCLG) established by the EPA or to the enforceable standard, the MCL? Or should the clean-up be to the aquifer's natural state?

Permits for Discharges onto the Land or into Aquifers. This traditional approach—controlling the sources of pollution by issuing permits—is another option some states are using to protect groundwater. The permit is a legally enforceable agreement between the state agency and the discharger; it usually involves calculating the amount of a discharge that will not violate the aquifer's corresponding standard. Using permits to control nonpoint sources of pollution is no easy task. New Jersey has established a permitting system to control some nonpoint sources, including the land application of sludges, some types of irrigation and waste lagoons and pits.

In the next few years, the development of national groundwater protection legislation will be the focus of chemical manufacturers, farmers, environmental and consumer groups, and state and local government officials. One of the most controversial questions will be how to assign responsibility, and therefore clean-up responsibility, for contamination. Consider, for example, the case in which a farmer's application of an agricultural chemical according to labeling instructions results in the contamination of a neighbor's well or a public water supply.

National Survey of Pesticides in Drinking Water Wells

In late 1987, EPA's Offices of Groundwater and Drinking Water will initiate a national survey of pesticide contamination in drinking water wells. The two-year survey will sample 1,200 domestic and community water system wells in all 50 states. Wells will be selected in counties that show varying pesticide use and groundwater vulnerability. The survey will not focus only on areas suspected to be contaminated.

The survey results will make it possible for the first time, to characterize the national level and distribution of pesticides in drinking water wells. It will also assess the relationship between hydrogeologic characteristics, pesticide use and residues in well water.

Well samples will be analyzed for the presence of 120 pesticides. Health advisories (see Chapter Three) have been prepared for "priority" pesticides that have the greatest potential for leaching into groundwater. A one-page summary of each health advisory is available from EPA upon request.

EPA is working closely with state and local governments in implementing the survey, and interested citizens may obtain a list of EPA's regional and state contacts upon request. For more information on the pesticides in groundwater survey, contact Jerry Kotas, Survey Director, USEPA, WH-550, 401 M Street, SW, Washington, DC 20460.

The Threat to Our Wells—Good News is at Hand

by Jay H. Lehr
Executive Director of the National Water Well Association

In 1980, 13 million households—37 million people—used private wells to pump water into their homes, according to the U.S. Census Bureau. Another 74 million Americans drank groundwater pumped to their homes by wells owned by water utilities. In all, 49 percent of Americans drink groundwater.

Groundwater contamination sources are varied and numerous. The many activities that can lead to pollution of groundwater suggest it will be difficult in the future to maintain the high quality of water from wells and springs unless greater care is taken to provide protection.

Eight out of ten Americans live near a toxic waste dump or source, according to the Council on Economic Priorities. These toxic sites can, and do, contaminate groundwater in certain instances.

A 1984 report by the U.S. Environmental Protection Agency's National Water Quality Inventory reported 4,400 incidents of groundwater contamination in 21 states that caused the closing of private, public or industrial wells and forced users to find alternative sources of water. Fortunately, contamination has probably closed fewer than 10,000 wells nationally, less than 1 percent of all U.S. water wells.

But it can be argued than we have polluted our groundwater unevenly and concentrated our misdeeds where dependence on it is greatest. In the industrial areas of New York, New Jersey and New England, we have indeed polluted much more than 1 percent of the groundwater. These areas have serious problems, but there is still a considerable amount of unpolluted groundwater available there.

One major source of contamination is holding ponds and lagoons, which are commonly used to hold oil field brines, municipal sewage and a variety of wastes, including industrial chemicals. Holding ponds and lagoons should be prohibited near groundwater unless it can be shown, beyond doubt, that fluids will not leak from them. In practice this necessitates use of an impermeable lining that has been proven to be effective in retaining the fluids of concern. It is estimated that presently only about 30 percent of the industrial lagoons and dumps are lined; 22 percent of municipal lagoons and only about 16 percent of the agricultural lagoons and connected activities have linings.

A growing problem of substantial consequence is leakage from some of the nation's estimated four million underground storage tanks and their associated piping. For example, in some cases, gasoline has percolated into groundwater. Less dense than water, the gasoline floats on the groundwater surface and leaks into basements, sewers, wells and springs, causing noxious odors, explosion hazards and fires. Groundwater contamination from these underground tanks can be minimized by periodic inspections of tanks and pipelines, including pressure testing, and by careful monitoring of fluid levels and inflow-outflow comparisons. Supporting substructures must be capable of sustaining the weight of loaded tanks in order to prevent settling, which may cause rupturing of pipelines leading to or from the tank.

Another significant cause of groundwater pollution is the one trillion gallons of effluent from the 22 million commercial and residential septic tanks, cesspools and privies. Individually of little significance, these devices are important collectively because they are so abundant in areas not served by sewage treatment systems. These same areas often rely on private wells for water supply, and the close proximity and density of septic tanks to groundwater installations can create serious pollution problems. This problem can be controlled by regulating construction and installation of these devices. Requirements setting satisfactory subsurface soil and rock conditions and adequate land use regulation, including limitations on the number of septic tanks per unit area, are needed.

Several years ago, prevailing opinion held that once fouled, groundwater was nearly impossible to restore. Prevention and protection from pollution are always the first line of defense, but today there are means of containing and rehabilitating contaminated ground water should it occur.

Generally, groundwater contamination problems are somewhat less catastrophic than many believe, better understood than some will admit, and manageable with a few exceptions.

The containment and/or control of contaminated groundwater can generally be accomplished using one or a combination of several available techniques found within three broad categories: physical containment measures; aquifer rehabilitation; withdrawal, treatment and use.

By the year 2000, this nation will have reduced new hazardous, toxic and troublesome emissions into our groundwater to less than 10 percent of their present level. We will still be left with decades of work to contain, control and remove the mess we've been making throughout most of our lifetimes, but it will be seen clearly as a manageable job.

6 Alternatives to the Tap

In communities large enough to support the necessary infrastructure, central treatment (a public water system) generally is the most practical means for providing safe drinking water. However, as the list of regulated contaminants continues to expand, many systems, particularly smaller ones, may find it prohibitively expensive to upgrade.

The alternatives to central treatment include home treatment devices and bottled water. A home treatment device (i.e., home filter), is categorized according to the point where it is installed and treats water in the home. A "point of entry" (POE) device treats the water as it enters the home; with a point of entry device, all taps deliver treated water. A "point of use" (POU) device is installed and treats the water at only a single tap.

To date, home treatment devices and bottled water have usually been viewed as options for individual consumers interested in taste and odor control and/or the removal of selected contaminants. Only in a limited number of communities has this decentralized form of water treatment been used as a means for *solving* local contamination problems in private wells or the public water system. Decentralized treatment is usually used as an interim measure for reducing risks during emergency situations.

In 1985 EPA proposed criteria and procedures for public water systems that use home treatment devices in order to meet the proposed MCLs for volatile synthetic organic chemicals and flouride (these are now final). This rule has raised many of the broader questions concerning the management of drinking water. Should home treatment devices or bottled water be considered a means of maintaining compliance with MCLs on a permanent basis? Are they an affordable option for small communities and rural areas?

Home treatment devices require careful maintenance. What is the best way to ensure the proper maintenance of these devices and who should be responsible? The consumer? The utility? The party responsible for contaminating the water?

Does the use of bottled water and home treatment devices by those who can afford them prevent some from receiving an alternative source of safe drinking water?

Does their use lessen public support for maintaining or upgrading community water systems?

One Community's Experience

In rural areas, where the majority of the population relies on individual wells, contamination of the shared aquifer can present serious institutional and technical difficulties to ensuring safe drinking water. When expansion of the public water system is uneconomical, options available to the homeowner include deepening an existing well if possible, use of bottled water or home treatment devices.

In Suffolk County, Long Island, 30 percent of the population is served by household wells; in all, three million people are completely dependent on groundwater. In 1979, contamination of groundwater supplying both private wells and small public systems by the agricultural pesticide aldicarb in the townships of Riverhead and Southold forced Suffolk County to confront some of the questions raised above.

Long Island is an especially sensitive area for groundwater contamination with pesticides due to its sandy soils, shallow water table and its high average annual rain and snow fall. Aldicarb, commonly used on potatoes, soybeans, peanuts, cotton and ornamental plants, is a pesticide which, due to its high water solubility, is taken up by the roots of plants and fatally ingested by insects. Aldicarb is acutely toxic to humans—causing nausea, headache, weakness and, in severe cases, convulsions, coma and death. Aldicarb levels ranging from 1 to 400 ppb were measured by Union Carbide, the manufacturer of the pesticide, in one-fourth of the wells located near potato fields. The New York Department of Health established a state drinking water standard of 7 ppb for aldicarb.

In assessing water supply alternatives for individuals with contaminated wells, the county looked at the cost and practicality of five options. These options ranged from installing individual home treatment devices to constructing neighborhood, community or regional water treatment systems.

Because the area is largely rural, with only a few small public water systems serving the population and the remainder of individuals on wells, the county decided to install individual home treatment devices as the most practical means of providing safe drinking water for residents. Union Carbide installed 2,500 home treatment units (in this case carbon filters) throughout the area.

The county has ensured consistent water quality to each homeowner's tap by defining a "point-of-use district." This district is defined as the area where treatment devices are provided. Management of the district is the responsibility of the municipality and is regulated as a community water system, subject to the same local, state and federal regulations.

This is the first instance in which a community has chosen to rely on home treatment devices to treat contaminated private wells. The town of Southold, in which there is no provision for publicly supplied water, is establishing point-of-use as the long-term solution to a contaminated water supply. The town of Riverhead, on the other hand, with a small public water system, is using point-of-use as an interim solution until the community water system can be extended to supply water to the affected households.

(Largely due to this incident, in 1980 EPA restricted the use of aldicarb on potato fields and banned its use in the vicinity of drinking water wells. To date, EPA has not established a federal drinking water standard for aldicarb, although a health advisory has since been issued.)

Three Perspectives on Alternatives to Central Treatment

Homeowners considering a home treatment device or bottled water as an alternative to the tap should first do some careful research into local drinking water quality to determine if an alternative is actually necessary and then into the various products on the market. In the case of home treatment, different devices remove different contaminants for different periods of time. In the case of bottled water, its treatment and requirements for its content vary (mineral waters are allowed to have higher levels of substances than are spring waters, for example). Some bottled waters are disinfected spring water, while others may simply be publicly supplied water treated with ozone to remove chlorine taste and odor. A detailed discussion of these alternatives to central treatment is beyond the scope of this publication. We do, however, present three of the many opinions on the subject of alternatives to the tap, two written by representatives of the industries involved and one by a public water supplier. Additional sources of reading on the subject are presented in the bibliography.

Should I Have My Water Tested?

Fear of contamination has caused many people to wonder whether they should have their water tested. If your water comes from a public water supply system and you have noticed a change in the color, taste or odor of your drinking water or if you just want information on what is in your drinking water, contact your local water utility operator. Routine monitoring is required to ensure that water quality meets standards for up to 22 substances of health concern, depending on your source water. Some public water systems provide for free sampling at the consumer's tap if a problem is suspected.

Local and state health departments can help you with information about a particular chemical or contaminant, its potential health effects, the dose levels that are cause for concern, or information about how your water system rates in comparision with others in the state. These agencies also may be able to supply the name of a reputable laboratory and cost information for testing.

If your water comes from a private well, the only way to know the quality of your water is to have it tested; there is no government agency responsible for routine monitoring of private wells for any type of contaminant. Contact your local or county health department to discuss what tests are recommended and for the name of an EPA-certified laboratory in your area. Two tests that private well owners may want to consider are a test for coliform bacteria and a "tox" test. If the level of coliforms exceeds EPA's standard of 4-coliforms-per-100-milliliters of water in a single sample, a second test should be performed and you may need to add a disinfectant to the water. Coliform bacteria are not harmful themselves; their presence, however, indicates that harmful (pathogenic) bacteria may be present. The "tox" test is *not*, as the name would seem to imply, a test for the water's "toxicity," but rather a test for total organic halides. The halides are a family of organic compounds representing a large percentage of the organic compounds that EPA will be regulating in drinking water during the next five years. The "tox" test will not identify specific compounds but will indicate whether your water needs additional testing.

The following national water testing labs can also test your water:

Aqua Associates, Inc.
P.O. Box 1251
West Caldwell, New Jersey 07006
(201) 227-0422

WaterTest Corp.
33 S. Commercial St.
Manchester, New Hampshire
(603) 623-7400

National Testing Labs, Inc.
6151 Wilson Mills Rd.
Cleveland, Ohio 44143

Hydro-Analysis Associates, Inc.
R.D. 1, Noble St. Extension
Kurtztown, Pennsylvania 19530
(215) 683-7474

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Bottled Water: An Alternative Source of Drinking Water

by William E. Deal
Executive Vice President of the International Bottled Water Association

Americans in growing numbers are turning to bottled water as an alternative to the tap. In 1985 more than one billion gallons of bottled water were consumed in the United States. According to trade statistics, the number of people drinking bottled water is increasing at more than 10 percent per year. At current growth rates, industry sales could top $2 billion in 1990.

The most frequently asked question about the industry is, why do people buy bottled water? Aesthetic factors are the driving force behind most purchases of bottled water. Consumer demand for water that looks clean and tastes good readily explains why bottled water sales are more concentrated in geographic areas where the aesthetic quality of water is poor. Per capita consumption of bottled water is greatest in the Southwest, where growing populations and limited water supplies combine to push total dissolved solids (TDS) levels up and consumer acceptance down.

Nationally, per capita consumption of bottled water is currently 5.2 gallons. Nationwide, one consumer in 17 uses bottled water. California, where one of every six consumers drinks bottled water, tops the national average by threefold. Today, health considerations, in addition to dietary, emergency and aesthetic factors, are beginning to affect buying habits. Even though the bottled water industry makes no health claims, customer inquiries and consumer interviews reflect a growing public concern about the safety of public and private water supplies.

Regarded as a food by the Food and Drug Administration, bottled water is the nation's most highly regulated and monitored drinking water supply*. All industry products must come from protected sources, be bottled in facilities regulated as food plants, processed using manufacturing practices approved by the federal government, delivered to consumers in sanitized bottles whose safety is assured by federal regulation, and so labeled as to provide public notification whenever the microbiological, physical, chemical or radiological quality of any bottled water product is substandard.

All bottled water is processed in some manner. International Bottled Water Association membership, representing more than 80 percent of U.S. sales, has standards that require that any nonchlorinated public water supply be treated by mechanical filtration and ozonation before bottling. If a chlorinated water supply is used as the source water, activated carbon filtration and ozonation are required. If the source water is a protected private water supply, such as a spring or well, the minimum treatment required is ozonation or other acceptable means of protecting the product against bacterial contamination.

Beyond these minimum requirements, most bottled water companies employ a more sophisticated range of technologies depending on the composition of the source water and the types of end products produced. Advanced water treatment techniques such as distillation, deionization and reverse osmosis may be used singly or in combination to produce demineralized water. Ozonation, approved by FDA, is used by most bottled water suppliers as a biological control agent rather than chlorine, which is used in most tap water supplies.

Under provisions of the Safe Drinking Water Act of 1974, and in keeping with a 1978 Memorandum of Understanding between FDA and EPA, the Environmental Protection Agency also has a definite impact on the regulation of bottled water. The 1974 act requires FDA to adopt revisions in EPA's National Drinking Water Standards for bottled water or publish in the *Federal Register* reasons for not doing so. Taken together with the requirement of FDA's Quality Standard, this FDA-EPA arrangement means that bottled water must meet all currently effective provisions of EPA's Interim Primary and all Secondary Drinking Water Standards. In addition to FDA, all states now regulate bottled water. No other drinking water is so highly regulated. Similar controls and safeguards are neither possible nor economically feasible for all water.

Frequency of inspection is a final measure of regulatory oversight. An IBWA survey of member companies shows that bottled water plants throughout the United States are inspected at least annually by a federal, state or local agency. In fact, most IBWA member plants are inspected several times a year.

Bottled water can contribute to the nation's future safe drinking water programs. We can and must depend on the bottled water industry as an alternative source of safe drinking water whenever (a) natural or accidental emergencies make a water supply unsafe, (b) the cost of bringing a public water supply or distribution system into regulatory compliance is prohibitive, (c) special health needs require low nitrate, low sodium or reduced fluoride diets, (d) a demand exists for drinking water that meets all primary and secondary standards, that is protected in sealed containers against contamination during distribution, and that looks clean and tastes good.

*Note: FDA inspects all registered bottled water firms. There is no requirement that firms register, although pressure is strong within the industry to register. FDA regulates only those bottled water firms working in more than one state.

Home Treatment

by Donna M. Cirolia
Director of Government Affairs for the Water Quality Association

During the past 50 years, producers of point-of-use and point-of-entry treatment devices have addressed the aesthetic quality of water by developing products that reduce hardness, improve taste, odor and color. These products are used in the home, either on a private well or as a supplement to the public water system, and in commercial or industrial establishments such as laundries, hotels and restaurants.

In recent years, this industry has taken on a new and growing facet—in-home treatment systems that are capable of reducing levels of health-related contaminants. This new avenue has resulted from increasing private and public water supply contamination by leachate from landfills, leaking underground storage tanks, agricultural runoff, industrial practices and individual septic tanks. The point-of-use (POU, single tap) and point-of-entry (POE, whole house) industry is focusing much of its efforts and attention on the 13 million private wells, 51,000 small community water systems and 151,000 noncommunity water systems such as schools, hotels and restaurants. Since many small central water systems are often plagued by a lack of financial resources and trained operators, point-of-use/point-of-entry equipment represent a potential cost-effective alternative. Currently, EPA is considering the point-of-use/point-of-entry alternative for systems to comply with drinking water standards. The pivotal issues that will affect EPA's decision include cost, monitoring, maintenance and whether to treat all of the water (POE) or just select taps (POU).

POU and POE products available today improve the quality of water, most economically, at the point where it is needed and only in the quantity that is needed. In most instances, water needs only to be treated at the tap. Since the average family uses only 3–5 gallons of water per day for drinking and cooking purposes, it makes economic sense to treat only the amount of water necessary. Ninety-nine and one-half percent of water supplied by a public water system is used for purposes such as sprinkling lawns, flushing toilets, cleaning streets, fighting fires, laundry, bathing and industrial uses.

However, there are some water quality problems that should be treated at the point-of-entry. For example, radon poses a health risk due to air exposure; thus a point-of-entry unit such as granular activated carbon or aeration should be installed. Aesthetic problems such as water hardness and iron are best treated at the point-of-entry.

Point-of-use/point-of-entry devices are just a different means of applying the same technologies used in central treatment plants. In many cases, combinations of these POU/POE technologies are used to solve multifaceted problems. For example, granular activated carbon filters are often coupled with reverse osmosis units to reduce organic and inorganic contaminants*.

Point-of-use/point-of-entry equipment may be leased for a monthly cost comparable to a local phone bill and purchased at a cost comparable to major home appliances. In light of minimal regulations affecting producers of these products, the Water Quality Association, in addition to others, currently has voluntary programs regarding personnel certification, product validation and advertising guidelines.

Tips for consumers considering purchase or lease of a point-of-use or point-of-entry system.

1. Have the water analyzed by a reputable laboratory to determine the quality of water.
2. Ask the local health department whether any contaminant(s) found pose a health or aesthetic problem and whether the water should be treated at a single tap or at the point of entry.
3. Deal only with professional, certified personnel (the Water Quality Association, for example, has its own certification program).
4. Research the water quality improvement products available before you buy.
5. Check performance capabilities, warranty, maintenance provisions and general operation.
6. Research the reputation and legitimacy of the company you choose. Check customer references and the Better Business Bureau before you sign a contract.
7. Beware the salesperson who tries to sell you one product to solve many different water quality problems.

Note: Point-of-use and point-of-entry devices that treat microbiological contaminants (micro-strainers) are also available.

Public Water Supply View on Bottled Water and Home Treatment Devices

by William J. Marrazzo
Commissioner of the City of Philadelphia's Water Department

As public water suppliers it is our responsibility to ensure that our customers receive the best available source of high quality water. Water, like other essential public services such as gas and electricity, cannot be manufactured and distributed solely on an open-market basis or be available only from specific outlets, because of the simple fact that it ***must*** be available upon demand and it ***must*** be top quality and affordable to all. Bottled water and home treatment devices are limited in scope by the fact that they cannot be obtained to replace all points in a distribution network.

One of the leading claims promoting bottled water over tap water is its "good taste and mineral content." The January 1987 edition of ***Consumer Reports*** compared the public water supplies of Los Angeles, San Francisco, New York, Chicago, New Orleans and Houston against 50 "still" and "sparkling" water products. In all areas of taste and mineral content, the public water supplies scored just as high, if not higher, than bottled water. Only in one area did public water score considerably ***lower*** than bottled water: cost. Bottled water costs for an eight-ounce glass ranged from 5¢ to 45¢. The same glass of tap water costs a fraction of one cent.

The price of bottled water therefore inadvertently excludes a population that cannot afford to pay the prices associated with bottled water. To lend to this perspective, a sampling of water costs for some major public water suppliers is offered, based upon monthly costs of 1,000 cubic feet with a ⅝ inch meter:

Tucson, Arizona	$12.40/mo.
Hartford, Connecticut	$12.78/mo.
New Orleans, Louisiana	$14.73/mo.
Columbus, Ohio	$15.31/mo.
Philadelphia, Pennsylvania	$11.53/mo.

These figures reflect the costs associated with ***total*** water consumption, i.e., drinking, cooking, bathing, etc. In contrast, the cost of bottled water per eight-ounce glass prohibits its use as the best means to equitably serve an ***entire*** population.

The cost of home treatment devices, whether it be point-of-entry (POE) or point-of-use (POU), may also preclude their use by a large segment of the population. Besides the cost for the treatment device, there are additional costs for replacing filters and monitoring to ensure that each device is functioning properly.

Home treatment devices require the homeowner's careful attention to ensure that trace levels of drinking water contaminants, trapped and concentrated inside the filter, are not released in a single flush due to malfunctioning or use of the filter beyond its recommended life. Protection from hazardous contaminants is more difficult to ensure in a decentralized operation which has less supervisory control over the finished product than at a central treatment plant. It should be remembered that use of home treatment devices will still require central treatment to ensure the greatest degree of safety. Take for instance the case of bacterial contamination. When the finished water leaves the treatment plant it is disinfected to prevent contamination from bacteria. Without this so called post-disinfection, home treatment devices using carbon adsorption techniques could actually contribute microorganisms to the water supply instead of taking them out.

Much of the appeal of bottled water and home treatment devices seems to hinge upon public perception that drinking water is contaminated with chemicals and the personal fulfillment that these alternatives offer to a status-oriented lifestyle. Bottled water has long been promoted as a "wholesome" and "healthy" alternative to tap water, endowing upon itself unique revitalizing qualities. However, ***all*** water naturally rehydrates the body after exercise, and publicly supplied water contains equivalent, if not more, mineral content as that claimed by most bottled water suppliers. The difference here seems to lie in the public water suppliers' unwillingness to spend operating revenue on the promotion of an essential public service.

Water supplied by public water suppliers is strictly regulated and monitored by the federal government through such laws as the Safe Drinking Water Act Amendments of 1986. Despite the public water suppliers' source, whether it be surface or groundwater, it must meet or exceed all physical, chemical, radiological and bacteriological water quality standards established by the EPA.

Although the same standards are imposed on bulk water, which is packaged in one-gallon plastic containers for drinking and cooking purposes, the enforcement of these standards does not adhere to the same rigorous monitoring and testing mandatory for publicly supplied water. In fact, such testing does not occur with any kind of frequency. In addition, the application of the Safe Drinking Water Act, as overseen by the Federal Food and Drug Administration, does not apply to mineral and "sparkling" waters used for consumptive purposes nor to imported bottled water. For home treatment devices, personnel certification and product validation programs run by the industry, and standards developed in cooperation with the National Sanitation Foundation for some types of treatment devices are only voluntary.

The assurance of high quality water is best accomplished through public support for central treatment. This ensures that high quality water is available to all consumers at all points in the distribution system and that the water will be treated by trained staff technicians, chemists and scientists employed by public water suppliers, using sophisticated equipment ***daily***.

7 A Guide to Citizen Action

While the federal government sets drinking water standards and requirements, it is at the local level where many decisions are made affecting your drinking water. This citizen's guide is designed to help you understand the treatment process used by *your* local water system, assess your own drinking water quality, and get involved in the decision making that affects the management and quality of your drinking water. Suggestions also are provided for private well owners.

A good way to begin is to contact local citizen and environmental groups, state and local health and environmental officials and your library. Ask what surveys or research may have been conducted, or is in progress, regarding local drinking water management, quality and local public health.

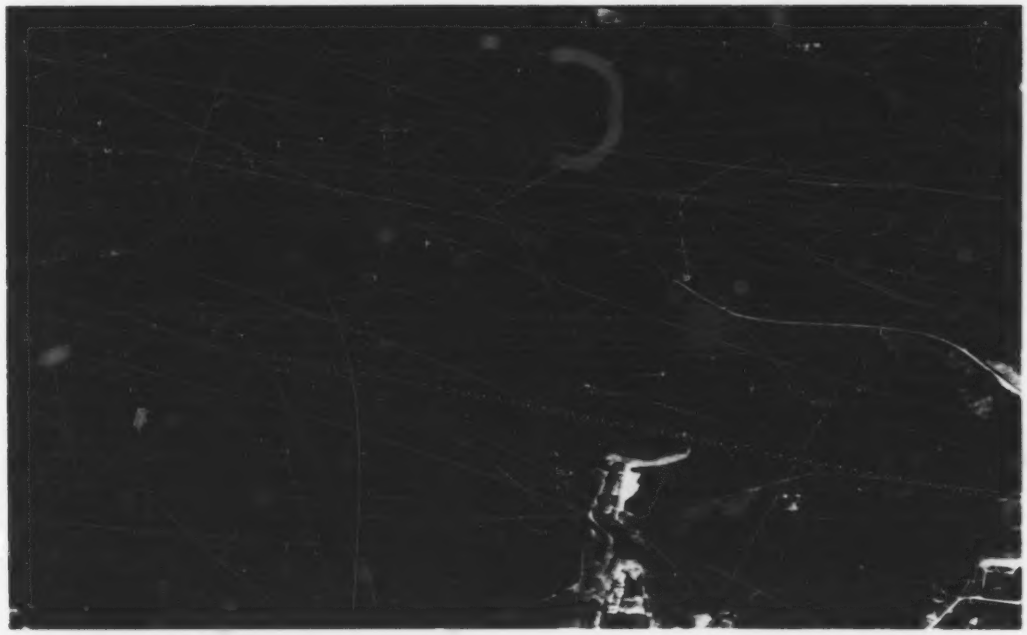
A second important step is identifying the local experts—those people who, out of personal or professional interest are knowledgeable about the water supply source, town/county ordinances and bylaws, and the water treatment process. The places to look for these local experts include the water treatment plant and the utility management, the town or city council, the city or county department of public works, the planning or zoning board, area universities and colleges, state and local health and environmental agencies, and industries with environmental health staffs. Also follow local and state newspapers for writers who frequently feature water-related articles or citizens who write letters to the editor about water quality.

Enlist the support of concerned citizens, individuals who know your community and those who are knowledgeable on the subject to participate in your research. Involving others from the start will provide a committed core group later if you decide to work for improvements. If no research has been done and you are working alone, you can still accomplish a great deal. Your findings may be the necessary impetus for organizing a citizens group later.

Find Out About Your Water Supply Source and Land Uses Impacting the Water Supply

Knowing where your drinking water originates and how it is continually replenished is important to understanding your water quality. Equally important is knowing how the land in the watershed is used, as these uses can directly affect the quality of the water collected in the watershed. Finding out how the land is used is a key step in recognizing the potential sources of contamination and the specific contaminants themselves, and for understanding the treatment process used to make the water potable.

A good way to find out where your drinking water has been is to get a map of the area. Contact your state office of the United States Geological Survey (USGS). It is likely they have mapped your watershed or can direct you to such maps. Next, locate—on your map—the land use activities in your watershed that have the potential to contaminate the drinking water supply. An excellent way to understand the big picture is to take a walking or driving tour of the watershed. An individual from the agency that controls the land uses in your watershed or your water district official will be able to help you here. Contact your regional council of governments or your city/county government to identify this land-regulating agency. For more information on the sources that most frequently contaminate drinking water, refer to Chapter One.



Where To Find Information Regarding Local Land Uses

The U.S Geological Survey, Public Inquiries Office will identify the USGS official in your state. (703) 648-6892.

The U.S. Department of Agriculture, Cooperative Extension Service is associated with universities in many states, is very knowledgeable about local conditions and works closely with rural residents on water quality concerns. For state and local contacts call (202) 447-4111.

The National Rural Water Association has affiliates in 34 states that operate training and technical assistance programs for small water systems. These individuals are excellent sources of general safe drinking water information and are familiar with local conditions. NRWA, Box 1428, Duncan, Oklahoma 73534. (405) 252-0629.

The U.S. Environmental Protection Agency maintains water supply data and a hotline for all drinking water questions. Contact the Office of Drinking Water, State Program Division, 401 M Street, SW, Washington, DC 20460. Or contact the hotline, 1-800-426-4791.

Your water treatment plant operator is the best source for finding answers to the following questions.

- Where does your water come from? A river, lake or groundwater source?
- What are some of the natural characteristics of your raw water, that is, before it is treated? How "hard" is it? Hardness will vary depending on its source as ground or surface water and local geologic conditions.
- What land use activities have the potential of impacting water quality? Industry? Farms? Urban runoff? Underground storage tanks? Landfills or surface impoundments? Are there any hazardous waste sites in your area?
- If your water supply comes from groundwater, have wells in the watershed been sealed to prevent foreign matter from entering them? Have any groundwater wells been closed or have any surface water supplies been abandoned due to contamination in your area?
- Is there any short-term or long-term plan for managing land use activities around the water source? If so, which state and local agencies develop and implement the plans? What sorts of budgets are allocated for these programs?

Find Out About Your Water Treatment Plant

Chances are that your water treatment plant operator will be the resident expert regarding the quality of the raw and treated water, the water treatment process itself, and the roles of local, county and state agencies in managing the drinking water resource. The plant operator can be an invaluable resource in supplying answers to the following questions:

- How many water districts serve your community?
- How many people does your district provide drinking water to?
- How old is your water treatment plant?
- What is the extent of the area that is serviced by your treatment plant?
- Have the district managers considered population growth in the area and planned to meet the water needs of expected growth?

Find Out About the Treatment Process

(For more information on water treatment, see Chapter Two.)

- Is your water filtered to remove solids?
- What pollutants are removed in each stage of the treatment process and in what amounts?
- Is disinfection provided to control waterborne bacterial disease? Many areas that rely on groundwater do not disinfect because most groundwater is naturally disinfected as it moves through soils to an aquifer. However, because contamination by microbiological organisms can occur even in these systems, the 1986 Amendments to the Safe Drinking Water Act will require *all* plants, large and small and surface and groundwater, to disinfect their water.
- How will this new requirement effect the plant's operation and costs?
- Will your plant apply for an exemption to the requirement or does it plan to disinfect? Assess the need for disinfection in your area by researching outbreaks of waterborne illness by contacting your local or county health official and by examining the plant's monitoring and testing records for compliance with levels of microbiological contaminants.
- If your water treatment plant does disinfect, is chlorine the disinfectant used? Surface supplies of drinking water have high levels of dissolved organic matter. When this water is treated with chlorine, trihalomethanes, a contaminant of health concern regulated by EPA, can form. Treatment plants serving greater than 10,000 people are required to monitor for levels of total trihalomethanes. Levels are required not to exceed 100 ppb. Regardless of the population served by your plant, ask your plant operator if total trihalomethanes have been measured or if they will be measured in the future. There is a trade-off between using chlorine as an effective and inexpensive disinfectant, and the formation and health effects of trihalomethanes.
- Are trihalomethanes a problem for your plant? If so, what does the treatment plant plan to do to reduce levels of trihalomethanes in the finished water? Methods that some plants have found successful are adding the chlorine at a later stage in the treatment process, using less chlorine or changing disinfectants.
- What other chemicals are used at each step of the treatment process and for what purpose? It would be interesting to compare the water treatment process used at your plant with the generic water treatment process described in Chapter Two.

Find Out About Testing and Monitoring

(For more information on monitoring drinking water quality, see Chapter Three.)

Ask to see the most recent monitoring report for compliance with all the federal drinking water standards and any additional state standards. Monitoring results are public information. Sometimes the measurement of contaminants in water ("parts per million") can be confusing. Don't be intimidated—first see Chapter Three which describes how contaminants are measured—and for more information consult a local or state health official.

- Does the bacteriological, chemical and physical quality of your treated water comply with the federal and state drinking water standards?

- If your water is disinfected with chlorine, where is this chlorine residual measured along the distribution system? Is there always a detectable chlorine residual, even in the most distant part of the system? Could less chlorine be used and still be an effective disinfectant? One reason chlorine is a popular disinfectant is its ability to be measured throughout the network of pipes delivering water to your home or office. If it can be measured, treatment officials know that it is working to keep the water free of pathogens between the plant and your home.
- Has your plant conducted monitoring for unregulated contaminants? If so, was this a one-time scan or part of a regular program? EPA's drinking water standards require that plants monitor for up to 22 contaminants (monitoring for an additional eight will be required over the next few years). As a result, unregulated contaminants might legally be present in drinking water. The 1986 Amendments to the Safe Drinking Water Act will require all plants, large and small, to monitor unregulated contaminants at least once every five years. If previous monitoring has been done, it would have been initiated by the state or district. Ask to see these results and discuss them.
- At what points in the water supply system (from source to tap) are samples taken, for what substances, and at what frequency?
- What does your plant official consider the most significant contaminant(s) of health concern locally?
- Who conducts the testing and monitoring? If it is done by the staff of your local treatment plant, what training have they had? Testing may also be performed by the state or county health department, EPA or a private lab.
- If monitoring is not performed by the plant, is this for economic reasons?

Find Out About Inspection

You can seek information on inspecting the water treatment plant from your local, county or state health department.

- Who conducts inspections of the plant?
- When was the treatment plant last inspected by a representative of the county or state government?
- Was a written report prepared? Is it available for review?
- Who is responsible for training plant operators? Are water treatment plant operators certified by the state?
- Has the state health department certified any bacteriological and/or chemical laboratories used?

Find Out About Storage and Distribution

Discuss preserving the quality of treated water with your water treatment plant or water district official.

- Where is the water stored after treatment? In a reservoir? What measures are taken to protect it from animal intrusion and vandalism?
- Is there enough storage capacity to provide a reserve of drinking water for all reasonable demands? For an emergency?
- Is there a program to detect and correct leaks in the line, or to repair older sections of the distribution system?
- Are there any lead mains or service connections in the distribution system delivering your water? If so, are there any plans for their removal? In many areas, drinking water is now the major source of environmental lead exposure. The 1986 Safe Drinking Water Act Amendments ban lead pipes, solder and flux from use in drinking water systems and new home plumbing by June 1988. Find out what steps state and local government have taken to ensure that building and plumbing codes are altered accordingly and that those whose commonly use lead solder and flux understand the lead ban. Enforcement may vary from state to state. You may want to encourage your local hardware stores to clearly label which solder and flux is lead-free.

Find Out About Public Information

(For more on public notification, see Chapter Three.)

- Does your water plant have a public information program?

- When the water treatment plant fails to meet the requirements of the Safe Drinking Water Act, when and how is the public notified?
- Is a comparision with federal or state drinking water standards made public at the time of public notification?
- Have any violations occurred in that last year in which public notification was required? Was the public notified? Ask your water district official to show the notifications and to discuss their clarity and tone.
- If your water treatment plant has received a variance or exemption from the requirements of the SDWA, what contaminants or requirements are involved? Under the Safe Drinking Water Act, treatment plants can be granted an exemption or a variance from meeting the requirements.
- Has a schedule for compliance been established and if so, what is it? Is the utility meeting that schedule? If not, why?

Find Out About Your Water Rates

The primary source of rates information is the public utilities commission for privately (investor) owned utilites and the water district governing board for publicly owned utilites.

- Has the price of your drinking water reflected the costs of its treatment and distribution up to this time? If not, why?
- How are the water rates derived? Has this changed over the past decade? Is there any plan to change rates?
- How is the treatment plant financed? Does it receive any state or federal funding?
- Does the water district anticipate increased costs for treatment and distribution as a result of the 1986 Amendments to the Safe Drinking Water Act? If yes, where will costs increase?
- What options are available to the water district for meeting these costs?

Questions for Users of Private Wells

The Safe Drinking Water Act provides no protection for those who rely on individual wells for drinking water. But there are steps that users of such wells can take. As a first step, find out what state or local regulations apply to the siting, drilling, operation and maintenance of private wells. Many states maintain records of where and when wells are drilled. The state or local health department will help you here. Refer to the previous section on finding out about your water source for ideas on learning about the aquifer that supplies your well and the land and water use activities that can affect your well. Because there is little or no government regulation over the quality of private wells, the following questions apply to you, the well owner.

- When was your well drilled? When was the last time the water in your well was tested? Was it when the well was drilled or when you purchased your home? Would you be required to have the water in your well tested before selling your home? If you are considering having your well-water tested, see Chapter Six.
- Does your home rely on a septic system for treating your wastewater? A septic system is a series of tanks buried (usually) on one's homesite. As the wastewater enters the septic tank, solids settle out and bacteria begin to decompose the waste. Liquid overflow enters a set of perforated pipes which slowly drain into the surrounding soil. Maintaining your septic system so that it functions properly is absolutely essential to ensuring that its contents do not contaminate your well. When was the last time you cleaned or pumped your tank? To be safe, you should have it cleaned or pumped annually with nontoxic and biodegradable tank cleaners.
- If your home relies on a septic system for wastewater, do you dispose of household hazardous wastes such as pesticides, medicines, paint thinners and other solvents, ammonia or other cleaners down your drain? If so, you can be certain that they prevent your septic system from functioning properly by killing the organisms that decompose human waste and therefore substantially increase chances that these substances could contaminate your drinking water well.

Getting Involved in Improving Your Drinking Water Quality

With answers to the previous questions, you know a great deal about the quality and management of your community's water supply. Are improvements necessary? Improvements might include:

- increased funding;
- improved monitoring and testing;
- repairs to the treatment plant and/or storage and distribution system;
- more stringent state regulations;
- more stringent regulation of land uses affecting the ground or surface water supply;
- alternative or additional treatment processes;
- additional or more stringent drinking water standards.

Your strategy for action will be determined by your community's priorities. Here are some techniques to consider in deciding on your goals and in achieving them.

Build a Coalition

Any actions you decide to take will be more effective in coalition with other individuals or groups that share your goals. Coalitions can pool resources, including information, political clout, funds and volunteers. Coalitions also demonstrate solid community support for change. Start by identifying your goals for water quality or management improvements.

Next, organize a meeting with a wide range of individuals you may have met during your research, including community leaders and decision makers, water treatment plant operators, public health and environmental officials, university professors, consumer advocates, industry and business representatives, to discuss your group's findings, what your goals are and what it will take to meet these goals. Identifying the most realistic and affordable ways to improve water quality may take a number of meetings.

Publicize Your Findings and Recommendations

With the community's support behind you and your coalition, chances of achieving your goals will be great. Meet with local newspaper reporters and write letters to the editor reporting your findings. Urge local television and radio stations to cover the issue. Offer to provide information and interviews. Keep the media informed of your progress, of meetings and events. Use local libraries to post your findings and to get others involved. To teach the importance of drinking water protection and how water is made drinkable, work for the active support of school teachers.

Take Action

Present your group's case to the proper legislative body. For changes in land use management, this may be the local zoning board; for rate increases or a change in the rate structure, it would be the public utilities commission (privately owned utilities) and the water district governing board (publicly owned utilities); for health concerns, it would be your local, county or state health department. Also enlist the support of your state legislators and other elected officials; urge new legislation for a future legislative session. Testify at public hearings if the opportunity is available. If problems in your community are serious, make drinking water an election issue.

Remember, drinking water is everybody's business. The benchmark of citizen, community and water suppliers' success in assuring a safe drinking water supply will be the confidence with which we can turn the tap—not only for drinking, but for cooking, bathing and recreational purposes.

The 1986 Amendments to the Safe Drinking Water Act will not be effective in assuring safe drinking water without the active support of citizens. We have witnessed in the past several years a shift in responsibility for financing water treatment, along with other municipal services and infrastructure, to states and localities. And while Congress authorized funding to assist with the new SDWA requirements, to date, much of this funding has not been allocated. Citizens, the ratepayers, must work closely with water suppliers and with state and local governments to choose affordable strategies for meeting the 1986 requirements that protect the health of all citizens. Safe drinking water is not out of reach; it is the tangible product of sound decision making.

Glossary

acute effects—the adverse health effects experienced shortly after exposure to a substance or mixture of substances.

aquifer—a geologic formation made up of rocks, sand or gravel saturated with water and replenished suffiently to produce a reliable supply.

best available technology (BAT)—the best treatment methods that can be achieved based on current technology and economics.

carcinogen—The following are categories used by EPA:

Group A: known human carcinogen—sufficient evidence from epidemiological studies to support a causal association between exposure to the chemical and human cancer.

Group B: probable human carcinogen—sufficient supporting evidence that the chemical causes cancer in animals but limited, inadequate evidence for carcinogenicity in humans.

Group C: possible human carcinogen—limited evidence of carcinogenicity of the chemical in animals and an absence of evidence for humans.

Group D: not classified as a human carcinogen—an absence of evidence for animals or humans showing the chemical to be carcinogenic.

chronic effects—the health effects experienced over a long period of time following repeated or continuous exposure to a substance or mixture of substances.

coagulation—a step in the water treatment process in which suspended particles combine physically (upon chemical treatment) forming larger particles which then settle out or are large enough to be filtered.

community water system—any system that has at least 15 service connections used by year-round residents or that serves at least 25 year-round residents.

consolidated community systems—a number of separate individual facilities, each of which serves a community, but which are jointly owned and administered by a central company. A consolidated system may also mean a facility that purchases water from another organization.

corrosion control—methods used to prevent the dissolution of pipe materials into water.

deep well injection—injecting liquid wastes into an underground formation using a well specially constructed for that purpose.

disinfection—the removal or inactivation of infectious microorganisms in the water treatment process.

distribution system—the network of pipes used to convey water from the treatment plant to the tap.

drinking water standards—two categories of contaminants (primary and secondary) for which EPA has established permissible levels in drinking water.

epidemiology—the study of the incidence, distribution and control of disease in a population.

filtration—the process of removing suspended matter from water as it passes through beds of porous material such as sand or activated carbon.

giardia—a microscopic organism found in untreated water that is responsible for an intestinal disorder known as giardiasis.

granular activated carbon (GAC)—A treatment technique that relies on the adsorbent properties of carbon to remove contaminants from drinking water.

groundwater—water found beneath the earth's surface in zones of saturation.

hard water—water with a high mineral content.

inorganic chemicals—substances composed of matter that is other than plant or animal, ie, mineral.

maximum contaminant level (MCL)—the maximum permissible level of a contaminant in water based on the maximum contaminant level goal and taking economic and technical considerations into account. The level is also known as a primary drinking water standard and must be met at the tap.

maximum contaminant level goal (MCLG)—a nonenforceable health based goal set for a substance. Preceeds establishment of a maximum contaminant level.

microgram per liter (ug/L)—1 part per billion (ppb).

milligram per liter (mg/L)—1 part per million (ppm).

mutagen—a substance or mixture of substances capable of causing genetic change in future generations.

noncommunity system—a system classified as having 15 or more service connections or serving water to a daily average of 25 people at least 60 days per year.

nonpoint source—pollution from water runoff over the surface of the land.

organic chemicals—natural and synthetic compounds containing carbon.

ppb—one gram of solute per billion grams of solution; ppb and ug/L represent the same concentration.

ppm—one gram of solute per million grams of solution; ppm and mg/L represent the same concentration.

point source—a discrete, readily definable source of pollution such as a pipe or wastewater treatment plant.

potable—drinkable.

primacy—the characterization of a state that has been authorized by EPA to carry out and enforce the Safe Drinking Water Act in that state.

primary drinking water pollutants—the category of 30 contaminants for which EPA has set enforceable drinking water standards, known as MCLs.

priority pollutants—a list of 129 industrial pollutants regulated by the Clean Water Act.

public water system—any system, public or private, that serves an average of at least 25 individuals at least 60 days a year.

sedimentation—a first step in the water treatment process, when suspended material in water is settled out.

soft water—water with a low mineral content.

sole source aquifer—an aquifer that supplies at least 51 percent of a community's drinking water.

synthetic organic chemicals—man-made compounds containing carbon. This group includes the VOCs.

teratogen—a chemical or mixture of chemicals that can cause birth defects.

total dissolved solids—natural levels of dissolved minerals in water, measured in milligrams.

toxicology—the science of the nature and health effects of substances and their treatment.

trihalomethanes (THMs)—a class of compounds forming upon the reaction of chlorine and organic matter in water early in the treatment process. Chloroform, a probable human carcinogen, is the most common THM.

turbidity—a cloudiness in untreated drinking water supplies usually caused by suspended sediment; in certain conditions turbidity prevents effective disinfection.

unregulated contaminants—contaminants for which drinking water standards have not been established by EPA.

variance—a temporary waiver issued to a public water supply if characteristics in the raw water source make it impractical to meet the MCLs.

volatile organic chemicals—carbon containing compounds that evaporate easily at room temperature.

watershed—a region or area bounded peripherally by a water parting and draining ultimately to a particular water course or body of water (in this case a source of drinking water).

water utility—a system responsible for the treatment and distribution of drinking water to the public.

wellhead protection area—the surface and subsurface area surrounding a water well or wellfield supplying a public water system and through which contaminants are reasonably likely to move toward and reach such water well or wellfield.

zones of saturation—layers of rocks, sand and/or gravel saturated with water beneath the earth's surface.

Publications

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A Citizen's Guide to Drinking Water. Environmental Protection Agency. 401 M Street, SW, Washington, DC 20460. 1987. Free.

A Citizen's Handbook on Groundwater Protection. W. Gordon, Natural Resource Defense Council. 122 East 42nd St., New York, NY 10168. 1984. Out of print.

America's Water: Current Trends and Emerging Issues. Conservation Foundation. 1717 Massachusetts Avenue, NW, Washington, DC 20036. 1984. 114 pp. $7.50.

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Groundwater: A Citizen's Guide. League of Women Voters Education Fund. 1730 M St., NW, Washington, DC 20036. 1986. 21 pp. $1.75.

Groundwater Contamination: 1983–1986. Institute for Alternative Agriculture, Inc. 9200 Edmonston Rd, Suite 117, Greenbelt, Maryland 20770. Free.

Groundwater: New Perspectives, New Initiatives. Journal of Fresh Water. Freshwater Foundation. 2500 Shadywood Rd., Box 90, Navarre, Minnesota 55392. 1985. 64 pp. $10.00.

National Groundwater Protection Strategy. U.S. EPA. 401 M St., SW, Washington, DC 20460. 1984. 56 pp. Free.

Groundwater Protection: Saving the Unseen Resource; Guide to Problems, Causes and Government Responses. Conservation Foundation. 1250 24th St., NW, Washington, DC 20037. 1987. 256 pp. $15.00.

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Pesticides in Groundwater: Background Document. U.S. EPA. 401 M St., SW, Washington, DC 20460. 1986. 70 pp. Free.

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Science, Risk and Public Policy. W.D. Ruckelshaus. *Science* 22. 1983.

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The Safe Drinking Water Act: Self-Study Handbook, Community Water Systems. American Water Works Association. 1010 Vermont Ave., NW, Washington, DC 20005. 1986. $22.00.

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Water: The Nature, Uses, and Future of Our Most Precious and Abused Resource. F. Powledge. Farrar Strause Giroux. 19 Union Square West, New York 10003. 1982. 423 pp. $7.95.

Water Quality Association and American Society of Agricultural Engineers Technical Papers. The Water Quality Association. 4151 Naperville Rd., Lisle, Illinois 60532. 1985. 82 pp. $15.00.

Drinking Water Hotline—The Environmental Protection Agency recently began taking calls for all drinking water questions 1-800-426-4791.

National Environmental Organizations

Citizen's Clearinghouse for Hazardous Wastes, P.O. Box 926, Arlington, Virginia 22216 (703) 276-7070.

Clean Water Action Project, 317 Pennsylvania Ave., SE, Washington, DC 20003 (202) 547-1196.

Concern Inc., 1794 Columbia Road, NW, Washington, D.C. 20009 (202) 328-8160.

Consumer's Union, 2001 S St., NW, Washington, DC 20009 (202) 462-6262.

Environmental Action Foundation, 1525 New Hampshire Ave., NW, Washington, DC 20036 (202) 745-4870.

Environmental Defense Fund, 1616 P Street, Suite 150, NW, Washington, D.C. 20036 (202) 387-3500.

Environmental Policy Institute, 218 D Street, SE, Washington, DC 20003 (202) 544-2600.

Freshwater Foundation, 2500 Shadywood Road, Box 90, Navarre, MN 55392-0090 (612) 471-8407.

Friends of the Earth, 530 7th St., SE, Washington, DC 20003 (202) 462-1177.

Interstate Conference on Water Problems, 955 L'Enfant Plaza Square, SW, Washington, DC (202) 466-7287.

National Audubon Society, 645 Pennsylvania Ave., SE, Washington, DC 20003 (202) 547-9009.

National Demonstration Water Project, 1111 North 19th St., Arlington, VA 22209 (703) 527-2282.

Natural Resources Defense Council, 122 East 42nd Street, NY, NY 10168 (212) 949-0049.

National Wildlife Federation, 1412 16th Street, NW, Washington, DC 20036 (202) 637-3700.

Sierra Club Legal Defense Fund, 2044 Fillmore St., San Francisco, CA 94115 (415) 567-6100.

Southwest Research and Information Center, Box 4524, Albuquerque, NM 87106 (505) 262-1862.

U.S. Public Interest Research Group (U.S.PIRG), 215 Pennsylvania Ave., SE, Washington, DC 20003, (202) 546-9707.

World Wildlife Fund/Conservation Foundation, 1255 23rd Street, NW, Washington, DC 20037 (202) 293-4800.

Health Information Organizations

American Public Health Association, 1015 15th St. NW, Washington, DC (202) 789-5600.

Center For Health Promotion and Environmental Disease Prevention, 7th Floor, 153 Tremont St., Boston, MA 02111 (617) 727-2662.

Center For Residential Health, 93 Sears Rd., Wayland, MA 01778 (617) 358-2348.

Center For Science In The Public Interest, 1501 16th St., NW, Washington, DC 20036 (202) 322-9110.

Community Health Improvement Program, Harvard School of Public Health, 667 Huntington Ave., Boston, MA 02115 (617) 731-1265.

National Toxicology Program, Public Information Office-B2-04, P.O. Box 12233, Research Triangle Park, NC 27709 (919) 541-3991.

Professional Membership Organizations

American Water Works Association, 6666 West Quincy Avenue, Denver, CO 80235 (303) 794-7711.

Association of Metropolitan Water Agencies (AMWA), 477 H St., NW, Washington, DC 20001 (202) 682-3998.

Association of State Drinking Water Administrators, 1911 North Fort Meyer Drive, Arlington, Virginia 22209 (703) 524-2428.

National Rural Water Association, 2915 South 13th, P.O. Box 1428, Duncan, Oklahoma 73534 (405) 252-0629.

National Sanitation Foundation, 3475 Plymouth Road, P.O. Box 1468, Ann Arbor, Michigan 48106 (313) 769-8010.

National Water Well Association, 6375 Riverside Drive, Dublin, OH 43017 (614) 761-1711.

Water Quality Association, 4151 Naperville Road, Lisle, IL 60532 (312) 369-1600.

State Drinking Water Contacts

Chief, Water Supply Branch
Department of Environmental Management
1751 Federal Drive
Montgomery, Alabama 36130
(205) 271-7773

Alaska Drinking Water Program
Water Quality Management
Department of Environmental Conservation
Post Office Box O
Juneau, Alaska 99811
(907) 465-2653

Manager, Compliance Unit
Waste and Water Quality Management
Room 202
2005 North Central Avenue
Phoenix, Arizona 85004
(602) 257-2305

Division of Engineering
Arkansas State Department of Health
4815 West Markham Street
Little Rock, Arkansas 72201
(501) 661-2000

Chief, Sanitary Engineering Branch
California Department of Health
714 P Street
Sacramento, California 95814
(916) 323-6111

Chief, Drinking Water/Ground Water Section
Colorado Department of Health
4210 East 11th Avenue
Denver, Colorado 80220
(303) 320-8333

Chief, Water Supplies Section
Connecticut Department of Health
79 Elm Street
Hartford, Connecticut 06115
(203) 566-1251

Program Director, Office of Sanitary Engineering
Division of Public Health
Jesse Cooper Memorial Building
Capital Square
Dover, Delaware 19901
(302) 736-4731

Chief, Water Hygiene Branch
Department of Consumer and Regulatory Affairs
5010 Overlook Avenue, SW,
Washington, DC 20032
(202) 767-7370

Environmental Administrator, Drinking Water Program
Department of Environmental Regulation
Twin Towers Office Building
2600 Blair Stone Road
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Director, Division of Water Supply
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Director, Division of Environmental Health and
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Chief, Bureau of Safe Drinking Water
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Director, Bureau of Public Water Supplies
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Organizations Represented by Contributing Authors

American Water Works Association is an international, nonprofit, scientific and educational society founded in 1881. AWWA has approximately 33,000 member utilities in North America. Based in Denver, Colorado, it is the largest water utility association in the world.

American Water Works Service Company is a management and technical services subsidiary that provides services at cost to 27 operating water companies in America. (These 27 companies serve 1.4 million customers in 500 communities in 20 states.) The corporation's headquarters are in Voorhees, New Jersey.

Association of Metropolitan Water Agencies is a national organization representing interests and concerns of the nation's larger metropolitan water supply agencies. AMWA's utility membership delivers drinking water to more than 60 million people nationwide. AMWA was formed in 1981.

Chemical Industry Institute of Toxicology is an independent, nonprofit organization that studies the toxicology of chemicals of public health interest. CIIT was founded in 1974 and is located in North Carolina.

International Bottled Water Association is a trade association that represents domestic and imported producers of bottled water. Founded in 1958, its primary activities include working with the government on regulations affecting water bottlers, public relations and technological training.

Water Quality Association is a nonprofit, international trade association representing more than 1,900 firms and individuals engaged in the design, manufacture, production, distribution and sale of equipment, products, supplies and services for providing quality water for specific uses in residential, commercial, industrial and institutional establishments.

Natural Resources Defense Council is a nonprofit membership organization dedicated to protecting endangered natural resources and to improving the quality of the human environment through legal action, scientific research and citizen education.

National Rural Water Association is composed of 40 state affiliate associates whose members are small, rural water systems. The nonprofit association was formed in 1976 and is headquartered in Duncan, Oklahoma.

National Water Well Association is a nonprofit, research, education and publishing company with 12,000 to 13,000 members. The association sponsors approximately 100 educational programs relating to ground water each year.